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THE AMERICAN BELL TELEPHONE COMPANY.

In another column we print a resume of the annual report of the American Bell Telephone Company for 1894, which shows a decrease in net earnings of some $800,000 as compared with the previous year, but yet the company was able to pay three millions in dividends to its fortunate stockholders. The statistics given show the enormous extent to which the telephone has entered into daily life, the total number of calls, for instance, reaching 670,000,000, annually, or about ten for every inhabitant of the United States. The number of calls for each subscriber averages 8½ daily, the cost per call being from 2 to 10½ cents, according to the character of the service. The report refers to the greater use by subscribers of their telephone service, which in the last six years has increased 40 per cent. The plan of charging telephone rentals according to the amount of service received is, we learn from the report, being generally adopted in the larger cities. The American Bell Telephone Company deserves much credit for the valuable statistics which it includes in its annual report, in this respect, at least, giving evidence of a public spirit not usually shown by corporations.

GAS BATTERIES,

Renewed interest has been excited in gas batteries through the discussion caused by the recent work of Ostwald and Borchers in this field, and, therefore, the series of articles on this subject by Mr. C. J. Reed, the first of which we publish in this issue, will, we feel sure, be welcomed by our readers. The subject is one upon which it is ordinarily not an easy matter to obtain information, the references to it in text-books and technical treatises being usually of a perfunctory character. The experiments recorded by Mr. Reed in the present article are not favorable to the gas battery as a possible means of transforming the energy of gases directly into electrical energy, his conclusion being that the electrical energy of the cell experimented with is from some other source than the combination of oxygen and hydrogen. In another column is an abstract of a Franklin Institute paper, by Prof. A. H. Bucherer, bearing on the same subject, the results claimed for the Borchers gas battery being severely criticised. In this case also it is demonstrated that the electrical energy obtained was not derived from the combination of the gases—carbon monoxide and oxygen—but by means of the solvent used for their absorption.

SYNCHRONOUS ALTERNATING MOTORS.

In another column we print the concluding portion of the paper of Profs. Bedell and Ryan on the action of a simple alternating synchronous motor. As here condensed from the original in the *Journal* of the Franklin Institute, the many references to other authors who have contributed to the same subject are omitted, as well as tables of data from which the diagrams we print were prepared, but otherwise the paper is complete. We may add that it furnishes the most complete non-mathematical exposition of the action of this class of motors yet made, and will repay careful study by the student or others desiring to become acquainted with the more complicated actions present in alternating current working. The important function of self-induction in a motor is very clearly brought out, as well as the effect of phase relations of the generator and motor currents and E. M. Fs., many of the points developed applying also to the theory of simple alternators. A very interesting property of the simple alternating motor here explained is its condenser action when over excited. This property, which, we believe, was first mentioned by Steinmetz, is likely to have a practical application in connection with alternating distribution, as by its means the inductive drop of the lines may be very simply nullified by connecting in properly designed motors of this type and running them

unloaded. The series of diagrams given with this section of the paper enable the relative action of the various factors entering to be easily followed, and, in connection with the curves printed in our previous issue, they show very clearly the effect of the armature reaction in the generator and motor on the self-regulation of the plant. The method adopted by the authors for explaining this branch of alternating current working is much more satisfactory than a mathematical one, and places a subject within reach of all which but a favored few could follow, if treated analytically, owing to the advanced knowledge of mathematics that would be required.

THE ELECTRICAL TRANSMISSION OF POWER.

The present year promises to be a fruitful one in the development of electrical transmission of power, which branch of the electrical industry may now be considered as firmly established on a commercial basis and with all of its electrical problems solved. The first 5,000-hp unit of the Niagara plant will start up in a few days, and the Folsom-Sacramento plant, an account of which we publish in this issue, is also well on toward completion, so that the many projects which have been awaiting a favorable practical demonstration will soon receive, we believe, the encouragement necessary to put them in course of execution. Whether it will pay to transmit power over long distances by electrical means is a question that does not need to be taken up at present, as transmissions over comparatively short distances are numerous enough to engage the activities of the industry for some time to come. It will, besides, be much better to confine attention to these latter, and let the commercial practicability of the more ambitious projects be determined by the result of gradual extensions of lines from plants which have been profitably established on the basis of shorter transmissions. In most of the discussions thus far on the commercial feasibility of electrical transmissions there has been much haziness in regard to the correct basis for comparison with steam power, the cost of an indicated horse power usually being compared with that of an electrical horse power, and even with that of an electrical horse power delivered in some cases. We believe that no authoritative test has yet shown a cost for steam power of less than $30 per annual indicated horse power, even for large units and cheap coal, which figure we will accept for comparison with the cost of electrical power from Niagara to Buffalo, on the supposition that in both cases the distribution of electrical current for power purposes is the final object in view. The Niagara company can sell with profit mechanical energy at the turbine shafts in its hydraulic station for $13 per annual horse power, and to put this on the same basis with a steam electric generating plant at Buffalo, only the losses, fixed charge and maintenance relating to the transmission line, step-up and step-down transformers should be considered, as the cost of the factors relating to the generation of current and its distribution apply equally to the case of the steam plant. For the line and transformer losses 80 per cent. would be a reasonable figure, which would bring the cost to about $16 per annual horse power, less the line and transformer charges, which latter would probably not increase the figure beyond $20. Accepting this estimate as approximately true, it follows that steam power generated at Buffalo cannot compete with Niagara power in the generation of current for distribution in that city for power purposes, and we believe the same to be true with respect to electric lighting, the only extra factor of cost in this case resulting from the partial employment of continuous currents for that purpose at present. As to the competition of electric power with steam power in manufactories, there is only room for discussion where the quantity used is very large, and of these cases there are very few in even the largest city—perhaps not half a dozen in Buffalo. Recent estimates of the cost of power from these large plants have varied from $32.70 to $50 per annual horse power, and the lowest of these figures can almost undoubtedly be met by Niagara power. It should be borne in mind, however, that the profitable field for electric power will be in replacing small and moderately sized steam plants, where the cost of steam power varies from $50 to $150 per annual horse-power. Owing to the less space occupied, and the much greater convenience of electric power, an electrical transmission company should be able to contract in these cases for the replacement of steam by electric power at a figure very near the cost of the former, thus securing a margin of profit which will render financial success assured in many of the cases where it has been thought dubious through estimates made on the minimum cost of steam power generated in exceptionally large quantities.

The Westinghouse and General Electric.

No official statement has yet been made by the General Electric or Westinghouse interests in regard to the terms of the arrangement recently entered into by the companies, and referred to in our last issue. There are rumors that the agreement also includes an understanding as to prices, but no confirmation of any of the various details published in financial journals and elsewhere can be obtained, the officers of the company positively refusing to affirm or deny any report. It is probable that the secrecy maintained is due to the fact that numerous details as to royalties have to be settled before the deal can be finally consummated, as well as questions relating to prices, should this matter form part of the arrangement.

Gas Engine Electric Lighting Stations.

The progress of gas driven electric supply stations in Great Britain only recently received an impetus through the starting of the Belfast station, which, however, has been subjected to a check through the failure of the system at Coatbridge. At this latter station, which was originally designed to work with alternators to run in parallel, it has been decided to abandon the whole of the gas plant, and to substitute steam engines. It is not to be supposed that gas engine stations are to be discredited on this account, for it is pretty certain that the difficulties arose from attempts to run the alternators in parallel. At the Morecambe station some annoyance has been created by the water gas used in the engines, and it has been decided to remove the station to a locality outside the suburbs. Besides the stations which are using gas power entirely, there are not a few where gas engines are used for the light day load, a practice which seems to have a great deal to recommend it on economical grounds. With the exception of Belfast, all the stations entirely using gas employ a form of water gas produced from anthracite, but at Belfast the experiment of taking gas from the town mains is being tried.

Charging for Current.

In the remarks of Mr. John W. Lieb on the discussion of Mr. H. Ward Leonard's paper, printed in the March number of the *Transactions* of the American Institute of Electrical Engineers, he referred to the system of charging for current in use at Milan, Italy, according to which the consumer is at liberty to choose between two systems of payment. He may pay either on the basis, first, of a fixed charge of a certain sum, $5.75 per lamp installed per year, plus a charge of .67 cent per lamp hour as registered by the meter; or, second, a charge per lamp hour as registered by the meter on a sliding scale at a rate varying from a maximum of 1.5 cents per lamp hour, to a minimum rate of .96 cent, depending upon the number of lamp hours used per month per lamp equivalent installed. This system, Mr. Lieb added, covers fully and satisfactorily the question of a consumer's load factor, and gives the best consumer—that is, the one giving the company the greatest return per lamp installed—the benefit of the best rate.

A Scientific Society at Yale.

The scientific society of Sigma Xi has been formally established at Yale University. This society has for its object the advancement of scientific scholarship, and is in many ways similar to its literary sister, Phi Beta Kappa. The stimulus of Sigma Xi has had a marked effect wherever the society is established. At the opening of the society in New Haven last week the charter was presented by Dr. Frederick Bedell, representing the society, who is also a Yale graduate. A number of Yale graduates have already been actively connected with the society at Cornell University, where its influence is particularly strong, W. A. Anthony, F. Bedell and A. C. Crehore being among this number.

Annual Report of the American Bell Telephone Company.

We print below a resume of the fifteenth annual report of the American Bell Telephone Company from advance sheets:

The report states that the increase, within the year, of the aggregate number of subscribers reported by the various companies, was somewhat larger than that of the previous year, and taking into consideration the facts that general business throughout the country had not recovered its usual activity, and that the growth of the telephone business must be, in great measure, dependent upon the prosperity of commercial and manufacturing interests, the results have been on the whole satisfactory.

In comparing the gain in the output of telephones for the year 1894 over that of the year 1893—16,015 telephones for 1894, as against 13,771 in 1893—attention is called to the fact that in the months of January and February the returns exceeded the output by 3,472, so that the actual growth in number of telephones during the remaining ten months would be little short of 20,000 instruments.

Extensive additions and improvements of plant have been made by most of the companies, especially in the direction of underground and toll line construction. A greater mileage of toll wires has been added than in any previous year in the history of the business. Not including the cost of current repairs and renewals, the companies operating under our licenses have expended during 1894, upon extensions of lines and apparatus, $4,138,000, and for buildings to accommodate their exchanges $411,000, making, with the amount reported last year, a total of investment in telephone property in the United States of $77,500,000.

The pole line construction of the Long Distance Company last year consisted mainly of the line from Pittsburgh to Chicago *via* Indianapolis, and the line between Erie, Pa., and Norwalk, Ohio. No very important new places were reached during the year. The principal points to which service was opened were Richmond, Waterloo, Terre Haute and Michigan City, Ind.; Piqua, Tadmore, Columbus, Springfield, Zanesville, Cambridge and Chillicothe, O.; Wheeling, W. Va.; Danville, Ill., and McKeesport and Northumberland, Pa.

The construction department reports that the total of lines, Dec. 31, 1894, was 4,617.24 miles of pole line and cables, and 75,555.72 miles of wire. Of this there were constructed during the year 633.26 miles of pole line, and 9,379.71 miles of wire. The metallic circuit system has grown rapidly in favor, and at the close of the year the stations of 54,680 exchange subscribers were furnished with the equipment for this improved class of service, a gain during the year of 17,032.

The steadily increasing use which subscribers make of the exchange service continues to be a noticeable feature of the statistics furnished by the operating companies. On the average, each subscriber throughout the country now uses his telephone, upon calls made and received, 17 times per day. While this enlarged use is gratifying to the company as an indication of the enhanced value which the subscriber derives from the service, it is stated that the greater demand thus made upon the exchange system of necessity involves a corresponding increase in the cost of rendering service, and a larger investment per station for central office apparatus and trunk lines.

Comparing the latest statistics with those of six years ago, we find the total number of subscribers has increased by 42 per cent. Within the same time the average daily use of the exchange service by each subscriber has increased 40 per cent., and the number of employes engaged upon exchange work 76 per cent.

The great disparity in the number of calls made by different subscribers in the same exchange, who, though paying the uniform yearly rate require in the transaction of their business a widely varying amount of daily service, has led several of the companies, especially in the large cities, to consider the adoption of a plan for measured service, of which advantage can be taken by smaller users.

The plan has already been put in operation in New York, Brooklyn, Boston and some other exchanges. The choice is offered to subscribers of paying either the fixed yearly rate with unlimited local service, or a graduated scale of charges, dependent upon the extent of use within the year, the cost for connection lessening with the increase in the number of calls for which contract is made.

This system is an alternative to that of unlimited use, is equitable to those whose requirements for service are not large, and has commended itself to a considerable number of the telephone users in the exchanges named, some thousands being now connected on the measured service plan.

Referring to the authority granted by the Massachusetts legislature to increase the capital to fifty millions of dollars, but providing that in the first instance the stock should be offered to the stockholders at the market price, to be determined by the Commissioner of Corporations, having in view actual sales and "other pertinent conditions," and that what should remain undisposed of in that mode should be offered for sale by public auction, the report states the price at which 5,000 shares issued was thus fixed was $190 per share. One thousand six hundred and thirty-two shares were taken by stockholders; the remainder, 3,368 shares, were sold on the ninth day of February, 1892, by public auction, at an average price of $189.75 per share.

The suit of the United States vs. the American Bell Telephone Company and Alexander Graham Bell still remains pending, notwithstanding that the two Bell patents, No. 174,465, of March 7, 1876, and No. 186,787, of Jan. 30, 1877, which it was brought to annul, have both expired. The deposition of Mr. Franklin L. Pope was concluded May 15, 1894, and on June 15, 1894, the court extended until Jan. 1, 1895, the time within which the defendants might take further evidence. Owing to unavoidable interferences and to the illness of counsel for complainant, the time for taking defendants' evidence has again been extended to June 12, 1895. By that date, if no accident prevents, the defendants expect to have closed their testimony.

Referring to the suit of the United States vs. the American Bell Telephone Company et al.—the Berliner suit, so-called—the report states that an appeal has been taken to the Circuit Court of Appeals, and the cause is expected to be argued this month (April).

In the Western Union Telegraph Company vs. the American Bell Telephone Company, a decree was made by the Circuit Court allowing the motion of the plaintiffs to dismiss their case without prejudice. This motion was made upon the coming in of a report of the master finding that the plaintiffs were not entitled to the account asked for. An appeal was taken and the decree of the Circuit Court has been reversed by the Court of Appeals, the case being remanded to the Circuit Court for further proceedings.

In the thirteenth annual report it was stated that Edison's application for a patent for the carbon telephone had resulted in patent No. 474,231; but it was said:

"It is necessary to add, however, that Edison's foreign patents for the same invention, although applied for subsequently to the application in this country, had expired previously to the grant of the American patent. Our counsel inform us that the law is unsettled, whether in such cases the American application should be defeated by the expiration of the foreign patent, but that the better opinion is that the expiration of the foreign patent is immaterial."

The question involved has recently been determined by the Supreme Court in the case of the Bate Refrigerator Company vs. Ferdinand Sulzberger et al., which holds in substance that the domestic patent in such case is determined by the expiration of the foreign patent, notwithstanding that the domestic application is earlier than the application for the foreign patent. The result of the decision is to annul the Edison patent.

Referring to the Long Distance Company, the report states it had invested up to Dec. 31, 1894, in line construction equipment and supplies, $7,460,662.97. The company shows an increase in gross earnings in 1894 over 1893 of 13.4 per cent., the amount for 1894, gross, being $1,011,961.82. It will be remembered that the gross earnings for 1892 were $643,436.77; for 1893, $892,361.62.

The following is a comparative statement of earnings and expenses:

	1893.	1894.
Rental of telephones	$3,513 711 42	$2,502,992 17
Dividends	1,824,431 98	1,937,657 77
Commission from ex.-terr. lines	108,621 38	106,939 46
Commission from teleg. business	29,192 79	29,352 96
Real estate	68,097 06	69,675 09
Interest	225,936 28	196,455 11
Miscellaneous	11,086 08	5,172 38
	$5,781.076 99	$4,848,244 94
Expenses	$1,855,591 30	$1,724,459 87
Net earnings	$3,925,485 69	$3,123,785 07
Surplus account, December 31, 1893	$2,151,011 61	
Net earnings, 1894	3,123,785 07	
		$5,274,796 68
Regular dividends, 1894	2,400,000 00	
Extra dividends, 1894	600,000 00	
Reserve for depreciation of insts.	123,785 07	
		3,123,785 87
Surplus account, December 31, 1894		**$2,151,011 61**

The following are the ledger balances on Dec. 31, 1894:

DEBTORS.		
Telephones	$1,209,787 77	
Real estate	950,926 86	
Stocks	38,268,455 95	
Merchandise and machinery	14,232 70	
Bills and accounts receivable	4,355,554 55	
Cash and deposits	760,776 08	
CREDITORS.		
Capital stock		$20,000,000 00
Debenture bonds, 1888		2,000,000 00
Bills and accounts payable*		1,107,949 92
Patent account (profit and loss)		10,228,571 33
Profit and loss		5,849,444 13
Reserve		4,222,756 92
Surplus		2,151,011 61
	$45,559,733 91	$45,559,733 91

*Of this amount $900,000 is for the dividends payable Jan. 15, 1895, to stockholders of record, Dec. 31 1894.

The following statistics are compiled from the report:

	Jan. 1, 1886.	Jan. 1, 1895.	Increase over 1894.
Instruments in use	353,518	582,506	16,015
Exchanges	747	867	29
Branch offices	428	572	1
Miles of wire on poles	100,332	232,008	17,332
Miles of wire on buildings	10,043	14,525	1,967
Miles of wire underground	3,417	148,285	27,610
Miles of wire submarine	254	1,856	219
Total miles of wire	114,046	396,674	43,194
Total circuits	112,067	212,074	6,183
Total employes	5,438	11,094	673
Total stations	137,750	243,432	6,246
Extra-territorial and toll lines:			
Miles of pole lines	30,697	49,324	2,597
Miles of wire	41,745	180,557	26,451

The estimated number of exchange connections daily in the United States, made up from actual count in most of the exchanges, is 2,088,152, or a total per year of about 670,000,000. The number of daily calls per station varies in different exchanges from 2½ to 24, the average throughout the United States being 8½, which shows an increase of 6¼ per cent. from last year in the average use made of the telephone by each subscriber. The average cost to the subscriber varies, according to the size of the exchange and character of the service, from less than 2 to 10½ cents per connection.

The average daily number of toll connections is 38,324, or a total per year of about 12,000,000.

Electricity Direct from Coal.

In a paper read before the electrical section of the Franklin Institute, Prof. A. H. Bucherer discusses the work of Borchers from the standpoint of the energy theory. He first shows why Borchers had no right to expect from the reaction $2\,CO + O_2 = 2\,CO_2$ an amount of electrical energy that would be equivalent to the heat of combination; for although with many primary cells the E. M. F. as calculated from the heat of combustion does not materially differ from the actual E. M. F., yet with a reaction so vastly different from those of ordinary cells as the one utilized by Borchers, the assumption of equivalency is not permissible. The author deduces the Helmholtz equation establishing the relations subsisting between heat of formation, E. M. F. and temperature co-efficient. In proceeding to calculate the E. M. F. obtainable from the electrochemical combination of CO with oxygen, he first points out that the maximum amount of work obtainable from a chemical reaction is a definite quantity and is entirely independent of the kind of energy into which the chemical energy is transformed, so that if we can find this amount in mechanical units or any other units we need only express these units in equivalent electric units to obtain the desired amount of electrical energy, and if one electrochemical equivalent is concerned in the reaction the electrical energy is numerically equal to the E. M. F. To find this E. M. F. for the oxidation of CO it is most convenient to consider the work done by the expansion of the gases CO and O in the process of reaction. Deville finds that at 3,000° Celsius carbonic acid is dissociated into CO and O to an amount of 40 per cent. Prof. Bucherer calculates from this that at 0° Celsius and atmospheric pressure the fraction of dissociated CO_2 is $\frac{1.58}{10^{34.88}}$ and it follows that whenever CO and O combine at 0° Celsius and atmospheric pressure, this process is equivalent to the passing of CO and O from atmospheric pressure to the exceedingly small partial pressures with which they are present in the reaction products. Consequently, if they perform a maximum amount of work while reacting on each other, we know from the laws of gases that this mechanical work of expansion is proportionate to the absolute temperature and to the logarithm of the ratio of initial and final pressures. If 56 grams of CO and 32 grams of O react, the work is

$$W = 2RT \log_e \frac{1}{p_1} + RT \log_e \frac{2}{p_1} = RT \log_e \frac{2}{p_1^3} \text{ calories.}$$

Here p_1 means the partial pressure of CO. Evidently this partial pressure is $\frac{1.58}{10^{34.88}}$ atmospheres, therefore

$$W = RT \log_e \frac{10^{104.58}}{2} \text{ calories.}$$

The work done by 1 electrochemical equivalent expressed in electrical units which is numerically equal to the E. M. F. is obtained by dividing this value by 4×23039 and we obtain:

$$E = \frac{1.98 \times 273}{4 \times 23039} \log_e \frac{10^{104.58}}{2} \text{ volts} = 1.41 \text{ volts.}$$

This value holds for 0° Celsius; for 18° we have 1.406 volts, whereas the heat of formation would furnish the value 1.476.

The author further shows that if in a supposed reversible electrochemical system the E. M. F. obtained differs appreciably from the theoretical value, then the action which is expected to furnish the electric energy cannot take place. Borchers only obtained 0.5 volt, hence the combination of CO with O could not furnish the current he observed, and it follows that the E. M. F. obtained was at the expense of the solvents used for absorbing the gases. To say, as Borchers and Ostwald did, that already 30 per cent. of the potential energy of the coal could be converted into electric energy, while the steam engine converted much less, is, therefore, a grave error. The above calculation of the E. M. F. is the first one ever made for a real chemical reaction.

Steel and Iron for Field Magnets.

BY LEWIS T. ROBINSON.

The curves showing permeability of some excellent mild steel samples, published in your issue of March 16, by Prof. Jackson, certainly warrant his conclusion that for dynamos using a high field density steel is much superior to iron as a material.

However, his sample of good wrought iron possibly approaches the best. Iron of this quality is, no doubt, obtainable, perhaps some is slightly superior to it, but because a magnet is simply made of wrought iron does not always signify that it is better than steel. The best wrought iron may be better than the best low steel, but taking the average iron, this is probably the reverse.

A number of examinations of wrought iron samples have led to the conclusion that the general run of commercial wrought iron of

TABLE I.

$\mathfrak{B}$	$\mathfrak{H}$	μ
4,000	3.03	1,320
6,000	4.05	1,480
8,000	6.2	1,290
10,000	9.71	1,030
12,000	16.9	710
14,000	33.3	420
16,000	133.5	120

American make is about represented by Table I; also that there is much which is vastly inferior to this.

Steel also varies considerably, but a few founders are paying special attention to producing good dynamo castings, and selling the same on their magnetic merits, if not exactly on magnetic specifications showing tests made on their product. The castings furnished are pretty close to their representations, sometimes better.

Forges and rolling mills are generally giving their attention to producing material suitable for mechanical purposes, but knowing nothing of its magnetic properties beyond the fact that dynamo builders buy it, and it must be all right.

To show that information of this kind can be very misleading, Table II. gives results condensed from a recent test on some sheet

TABLE II.

$\mathfrak{B}$	$\mathfrak{H}$	μ
4,000	8.5	470
6,000	9.3	554
8,000	14.8	540
10,000	22.2	450
12,000	40.0	300
14,000	93 3	150

iron sold as being especially suitable for armature cores. It is apparent at once that it is of inferior quality for such uses.

The only purpose of this note is to call attention to the fact that all wrought iron will not develop a curve like the classic sample of Hopkinson, which is sometimes regarded as a fair basis to start from in judging of the comparative merits of a particular steel. Iron like this is scarce, indeed.

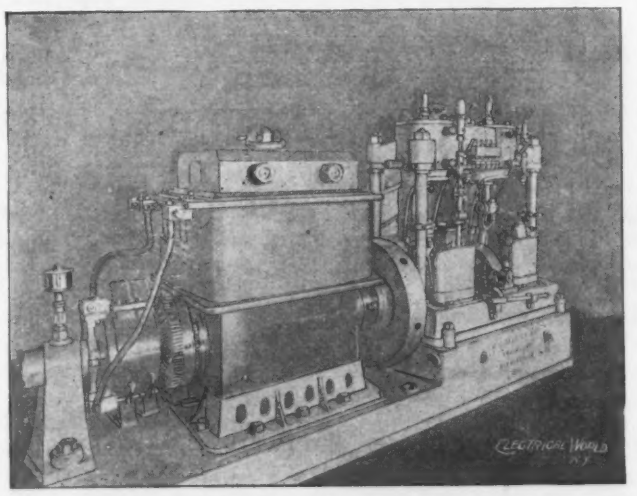
Electricity at the New York Navy Yard.

THE great extent to which electricity is employed in the new warships of the United States Navy would naturally lead one to infer that at the New York Navy Yard, where the principal naval electrical depot is located, there would be an extensive electrical establishment. This, however, is far from being the case, owing doubtless to the parsimony of Congress in its appropriations for other than the most pressing necessities of the naval service. Even in the electric lighting of its great workshops, the navy yard is behind the meanest private establishment, notwithstanding the pressure brought to bear on each successive Congress by the Secretary of the Navy for appropriations necessary to purchase and install a plant of the necessary character and capacity.

The machine shops aboard all of the larger men-of-war afford facilities for ordinary electrical repairs, thus relieving the yard shops to some extent. Aside, however, from repair work and the calibration of instruments, an important function of the yard electrical department is in the inspection and testing of electrical naval supplies and machinery, the exigencies of the service requiring that nothing shall pass into use until its reliability has been thoroughly established by the most rigid tests or inspection.

The electrical machine shop, dynamo room and the balance room are in Building No. 8. In the machine shop are lathes, shapers, milling machines, etc., driven ordinarily by a small steam engine. A 12-kw Edison dynamo is belted to the line shaft which transmits power to the machine tools, and under ordinary circumstances this dynamo furnishes current for lighting the shops and testing rooms. In case it becomes inexpedient for any reason to run the steam engine, the lighting circuit and dynamo are connected up with the Navy Yard street mains, the dynamo then being used as a motor to drive the machinery.

The current for heavy testing is supplied by the direct connected equipment imported from abroad, consisting of a Siemens generator of 80 volts and 400 amperes capacity, and a 40-hp Belliss double cylinder vertical engine.

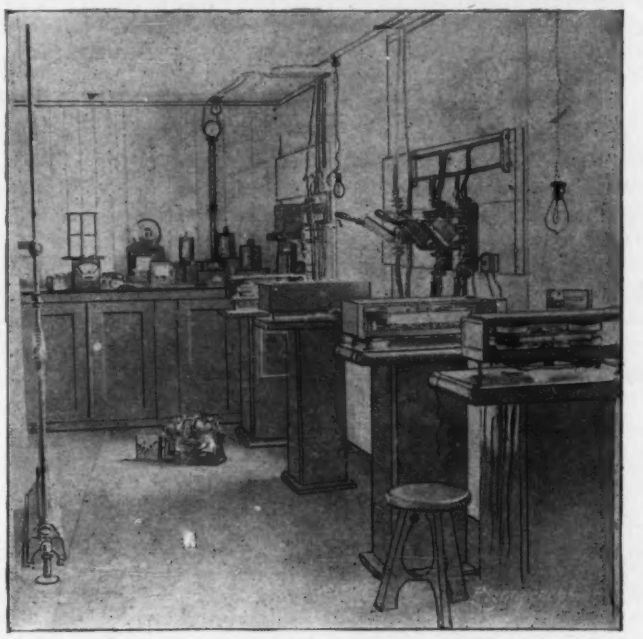


SIEMENS DYNAMO AND BELLISS ENGINE.

For lighter work a smaller outfit is used, consisting of a 2-kw General Electric dynamo direct driven by a Case engine. Both of these equipments, as well as the machinery above mentioned, are placed on substantial foundations entirely separate from the floor and foundations of the building so as to avoid transmitting any jar or vibration to the balance room.

The balance room is fully equipped with Thomson balances, a Cardew voltmeter, d'Arsonval reflecting galvanometer, Wheatstone bridge, etc., for testing and calibrating voltmeters, ammeters, etc., and standardizing resistances,

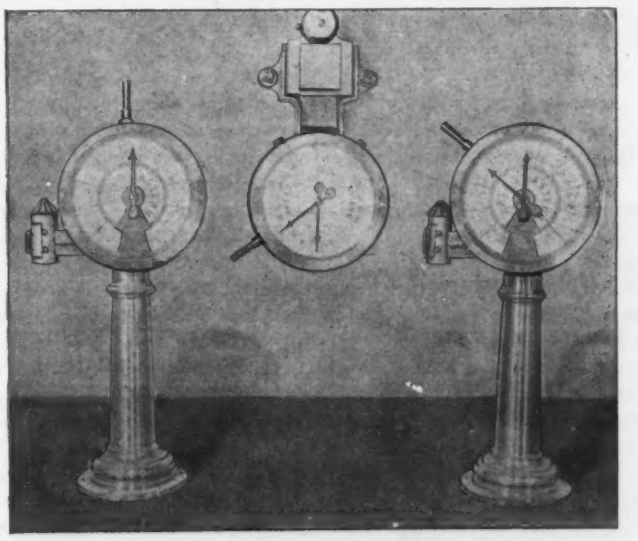
In Building No. 7 are the store room, and the lamp and cable testing room. The latter is provided with all necessary apparatus for making photometrical and insulation tests, both of which are very rigidly carried out. Ten per cent. of each lot of lamps is tested, and in the event that 30 per cent. of the lot fails to come up to specifications the entire shipment is rejected. The insulation test consists in immersing the wire in salt water 24 hours, then



BALANCE ROOM.

submitting it to heat at 200 degrees F. seven hours a day for seven days, and finally giving it another salt water bath for 24 hours. Wire intended for 110-volt circuits is tested between each bath and the baking under a pressure of 300 volts, and is rejected unless the insulation shows a minimum resistance of 1,000 megohms per nautical mile throughout the series of tests. The baking is accomplished by placing the coil of wire in the centre of an oven, the walls, floor and roof of which are covered on the interior with steam pipes. The coil of wire is supported on blocks so as to avoid contact with the hot pipes.

Among the multitude of supplies, instruments, etc., in the store room are to be found direct-connected marine electric lighting sets,



ENGINE-SIGNALING APPARATUS.

electric projectors, and electric engine signaling apparatus. The latter interesting device, made by Elliott Bros., London, is shown above, and its function is to transmit signals from bridge to engine room on board ship, replacing the gongs and pull wires commonly used for that purpose. The mechanism in the engine room is a duplicate of that on the bridge. In practice the officer on the bridge pulls the handle over to the right or left, according to the direction in which he wishes the vessel to be propelled, until the pointer attached to the handle indicates the speed at which it is desired to run the engines. The needle of the engine room appa-

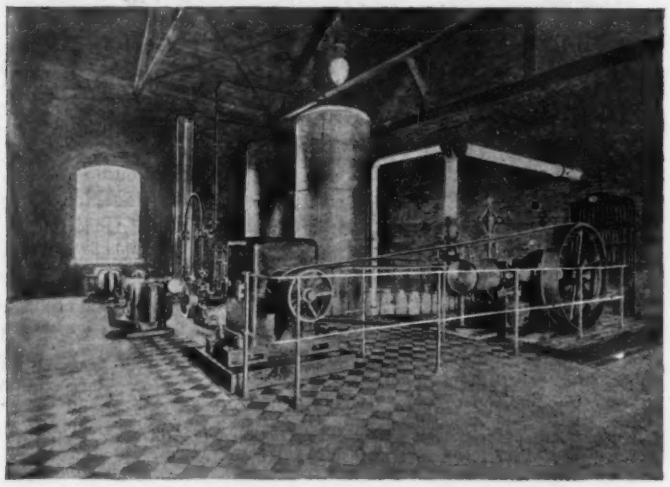
ratus moves in synchronism with the lever on the bridge, pointing out the speed and direction desired. The signal is acknowledged from the engine room by moving over the handle there until its pointer coincides with the signaling needle, which has the effect of moving the needle of the apparatus on the bridge exactly as the needle in the engine room was moved. Thus both engineer and pilot have a constant indication of the speed and direction of the engines.

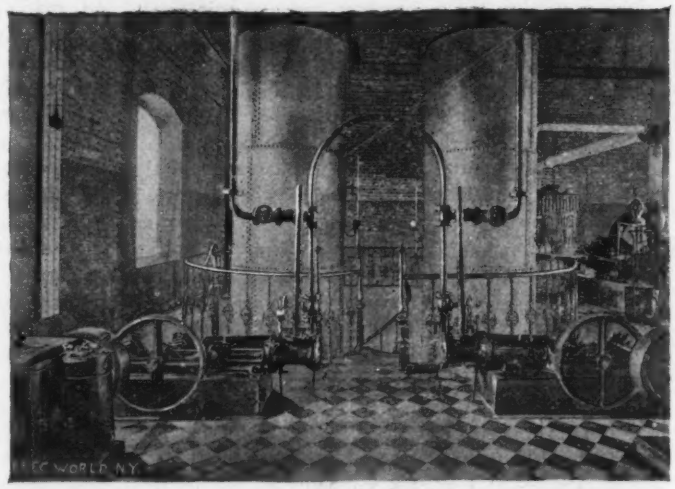
Much credit is due to Lieut. C. E. Roller, U. S. Navy, and his corps of able assistants for the excellent results they have been able to accomplish with an insufficient equipment and restricted funds.

A Combined Electric Lighting and Water Works Plant.

In a paper recently read before an electrical society of Cologne, Germany, Mr. Max Luhn described an interesting installation, consisting of a combined electric and water works plant, which has been recently laid down at St. Lazarus, a small suburb of Posen, having a population of 3,000.

These works have been running only about a year, but the wisdom of the step taken is already clear, for the town has developed most remarkably, and a large number of families has moved there from Posen, in order to secure better and cheaper lighting as well as excellent drinking water. Building operations are being very actively carried on in St. Lazarus, and the fact that the electrical machines are being run to their full capacity only a few months after their installation testifies to the great favor in which the new lighting system is held.





FIGS. 1 AND 2.—PUMPING STATION.

After borings had been made in a piece of land belonging to the town, with results which assured an abundant supply of excellent water, the town council called for bids for an electrical plant and water works. After a thorough examination of the plans of the competing firms the contract was awarded to the Helios Company, and work was begun in the fall of 1893.

The piece of ground in which the four artesian wells are bored lies at the highest point of a hill which rises above the whole surrounding country, and the pumps had therefore to be placed in a shaft 6.5 metres deep.

The whole plant may be divided into four parts: boiler house, eng ne room, pump shaft and accumulator room. Two Cornish steam boilers are set up in the boiler house; each of the furnaces contains six Galloway tubes, and the working pressure is 90 pounds. One boiler suffices for running the electrical machines and the pumping plant, while the second boiler is held in reserve. A chimney 110 feet high will be able to take care of still another boiler, which it is intended to set up this spring.

In the boiler house is a feed water heater of two cubic metres capacity, which uses the exhaust steam from the pumps and engines. The feeding is generally done with a Worthington pump, while an injector is held in reserve.

Next to the boiler house is the large engine room, in one corner of which is the pump shaft, 6.5 m deep and 5.5 m in diameter. At the bottom of this shaft stand two pumps, which can each deliver 30 cubic metres per hour. One of these is a compound steam pump, while the other is driven by an electric motor with toothed rack gearing. In the shaft are also two reservoirs, consisting of large air pressure chambers, 9 metres high and 1.5 metres in diameter. These take the place of an expensive standpipe.

In the engine room is a 50-hp steam engine, which drives a dynamo of corresponding power by means of a belt direct from the fly wheel. The engine has a single horizontal cylinder, and is non-condensing; under favorable conditions of steam consumption it delivers 50 effective horse power at 190 revolutions per minute. It is provided with all the modern improvements, and particular stress is laid upon thoroughly reliable and automatic lubrication of all its parts. An extremely sensitive governor regulates the entrance of steam and keeps the speed constant under the most varying loads.

The engine driven dynamo is designed for the charging of accumulators, and its electromotive force can be increased to suit the varying demands upon it. The peculiar construction of the dynamo, and especially of the armature, insures almost absolute safety of operation, so that for the time being no reserve set of machines has been put in. As a matter of fact, since the beginning of operations on March 15, 1894, there has not been the slightest disturbance in the machine plant.

On the wall of the engine and dynamo room is placed the white marble switchboard, on which are mounted the few pieces of apparatus necessary for the whole plant. Next to the switchboard is an electric meter which registers the whole current entering the distributing network of conductors for the town. Beside this meter there is a smaller switchboard, from which branch out five circuits for street lighting.

At the left side of the switchboard is an automatic regulator, which keeps the voltage constant at the feeding point situated in the middle of the town.

At either side of the entrance to the pump shaft is a "Burckhardt Weiss" air compressor, driven by electricity. These compressors serve to increase the air pressure in the reservoirs when necessary. The highest working pressure in the water mains is five atmospheres, used only in case of fire. The ordinary pressure is three atmospheres.

Next to the engine room is the accumulator room, which contains a battery of 136 cells. This battery is capable of feeding 200 16-cp incandescent lamps for seven hours, and in case of fire breaking out at night can also supply current to run the electromotor pumps and the compressors, while the stoker is calmly getting up steam.

Feeders run from the central station to the middle of the distributing network, which is carried out on the three-wire system. The arc lamps for street lighting have separate circuits, which are switched in and out from the central station. All the conductors are carried overhead on chemically treated (creosoted) wooden poles with porcelain insulators. On the same pole line are carried telephone wires, connecting the engine room with the office of the town council, and signal wires, by means of which, in case of fire, the engineer, who sleeps in the central station, can be notified from a fire alarm apparatus situated in the principal street. The arc lamps for street lighting are hung on ornamental wooden poles 10 metres high. A cast iron arm carries the lamp, which can be lowered for the renewal of carbons.

The central station is operated in the following manner:

By day, while the consumption of water is comparatively great,

the water supply is taken care of by the steam pumps, while the accumulators are charged by the dynamo. When the latter operation is finished, and also in case there is a large demand for water in the early morning before getting up steam, the electromotor pump is run with current from the storage battery. With the beginning of twilight the current for lighting is supplied by the dynamo, and at 11 o'clock at night, after the arc lamps for street lighting have been cut out, the machinery stops running, and the storage battery furnishes whatever current is needed. In case of fire breaking out at night, the engineer is awakened by the alarm bell, and he immediately puts the electromotor pump, as well as one compressor, in operation. This arrangement is of especial importance, and the town has already had an opportunity of convincing itself of the reliable working of the whole plant on the occasion of a fire which broke out at a very early hour in the morning.

By the employment of automatic apparatus for regulating current, and automatic lubrication for all the moving parts of the machinery, the attention needed by the plant is reduced to a minimum, and the whole station is most easily run by only one engineer and one fireman. Even after the second set of machines to supply the increased demand is put in, no more men will be needed.

The whole arrangement of the plant allows operations to be conducted to the greatest advantage, so that with current at three pfg. (0.7 cent) per 100 watt hours, and water at 16 pfg. (3.8 cents) per cubic metre, the town gets its service very cheaply. In fact, after the Posen freight depot has been connected with the water mains, in order to supply the locomotive boilers, the income from the sale of water will cover all expenses, and the income from current will be clear profit.

The town will, perhaps, reduce the charges for water and current in the future as its object in running the plant is not to make money, but to further the development of the place.

The favorable results reached in St. Lazarus have induced the neighboring suburb of Wilda to erect similar works, and last fall the Helios Company was given a contract to build a plant there of double the extent of the one in St. Lazarus. Owing to more favorable conditions of water supply, the engines in Wilda will be condensing, and even better results are expected than in St. Lazarus.

Another interesting plant which the Helios Company is building at Strasburg, in West Prussia, combines a slaughter house with an electric central station. The boiler plant and water supply are common to both, and in this case the attendance and running expenses are also reduced to a minimum.

It may here be stated that a great many of the smaller towns and villages are considering the question of light and water supply in the systems just described, and that a number of similar plans will be carried out in the near future.

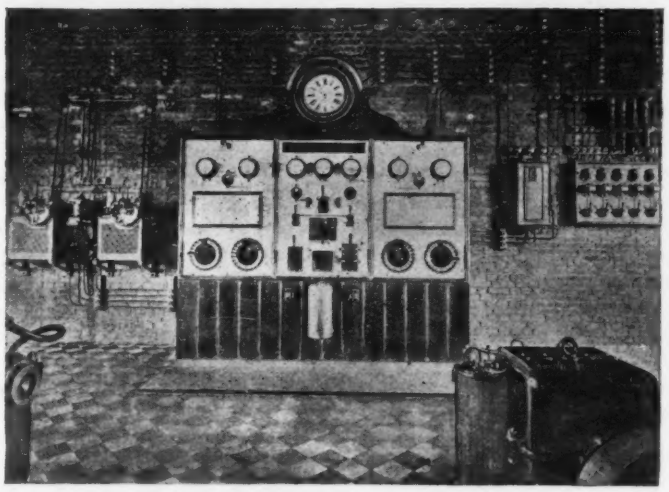


FIG 3.—SWITCHBOARD.

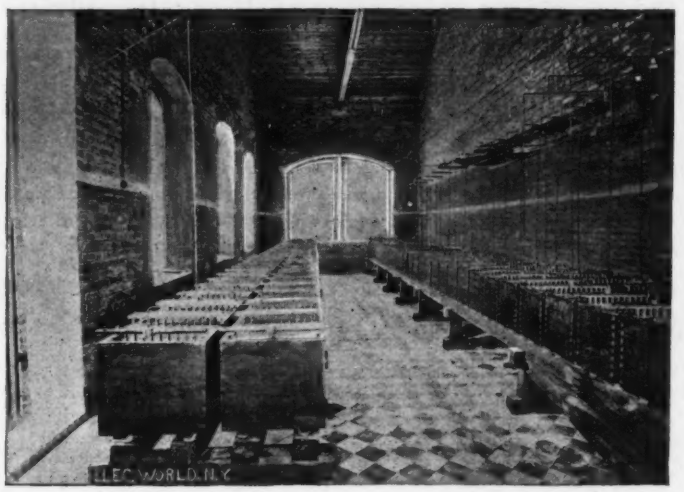


FIG. 4.—ACCUMULATOR ROOM.

Another Danger in the Use of Acetylene.

Besides forming an explosive compound when in contact with copper or brass pipes it appears from a recent discussion in Manchester, England, that the gas is easily decomposed by a shock, such as the firing of a percussion cap, and, therefore, it would be too dangerous to store this gas in the condensed state in steel cylinders as has been proposed.

Gas Batteries.—I.

BY C. J. REED.

The gas battery as a possible means of transforming energy of fuel directly into electrical energy seems at present to be the most promising, or at least the most attractive, of the very few roads to the practical solution of this important problem.

The experiments described below were undertaken for the purpose of determining to what extent and under what conditions hydrogen and fuel gases generally may be made to combine at low temperatures with oxygen in a gas battery. In order to determine this it is evident that we must use only electrodes and electrolytes that under the conditions of the experiment do not themselves undergo any chemical changes resulting in the ultimate formation of by-products other than the products of oxidation of the fuel gas itself. There are two reasons for this:

1. If other reactions take place in the cell it may be difficult to detect the electrical effect of a very slight reaction between the gases or to distinguish it from the effect of a reaction between other components of the cell.

2. If the components of the cell react chemically either upon one another or upon the gases employed, by products are necessarily formed that require regeneration. This kind of a solution of the problem we already have in the ordinary primary battery.

I believe it will be found necessary also to exclude a two-fluid cell, as it is very difficult (in my experience it has been impossible) to find any two different electrolytes that will not act as a primary battery and give considerable electromotive force when separated by a porous partition, each electrolyte being in contact with an incorrodible electrode, such as platinum or carbon. I have found several hundred such cells that give a very high electromotive force. This subject will be treated of later in a separate communication, and for the present it will suffice to give a single illustration.

Two carbon electrodes, one in contact with a mixture of potassic permanganate ($KMnO_4$) and dilute sulphuric acid (H_2SO_4), the other in contact with a mixture of potassic sulphide (K_2S) and sodium thiosulphate ($Na_2S_2O_3$), the liquids being separated by a porous partition, give an electromotive force of 1.84 volts.

In view of these considerations I decided to examine the reaction of hydrogen and each of the more common fuel gases upon oxygen in contact with dilute sulphuric acid and a pair of incorrodible electrodes.

Experiment 1.—Oxygen and hydrogen with electrodes of platinum foil.

Each electrode was 2.44 inches long, 0.5 inch wide and 0.001 inch thick (62x12.7x0.025 mm). At the middle of one end of the foil a piece of platinum wire 0.4 mm in diameter was soldered with pure gold. Each electrode was inserted in a glass tube 14 mm in inside diameter and 140 mm long. The wire passing out at one end was sealed through the glass at a distance of 10 mm from the end of the foil.

Two such tubes after being thoroughly cleaned were filled with dilute sulphuric acid of specific gravity 1.125 and inverted in a

beaker of the same solution. The apparatus was mounted as shown in Fig. 1.

Two platinum wires, *C* and *C'*, were inserted under the tubes and an electric current was passed through these wires until the tube, *T*, was filled with hydrogen to a point about 10 mm above the lower end of the foil. The wire, *C*, was then withdrawn from beneath its tube and left in the solution, the current still continuing, until the oxygen in *T'* was at about the same level as the hydrogen in *T*.

The wires, *C* and *C'*, were then removed and the tubes were heated by the flame of a Bunsen burner until the gases were expanded nearly to the mouths of the tubes. This heat was continued for about ten minutes and at the same time the beaker was heated on a sand bath to the boiling point, to destroy ozone and hydrogen peroxide.

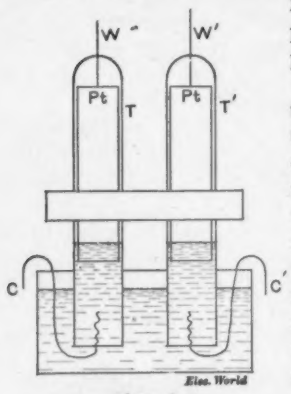


FIG. 1.

After the apparatus had cooled to the temperature of the room (20° C.), the height of the liquid was marked on the outside of each tube. The terminals, *W* and *W'*, were then connected to a Weston voltmeter having a resistance of 356 ohms, each division of the scale being 0.02 volt. Upon closing the circuit there was a throw of the needle reaching almost exactly one-half a division, indicating .01 volt. The needle returned instantly so nearly to zero that no deflection could be detected with certainty. There seemed to be a barely perceptible deflection indicating about .0005 volt. The circuit was opened for about five seconds and on closing again a similar instantaneous throw of the needle to half a divison of the scale was obtained. This could be repeated indefinitely.

Admitting that a constant current was maintained through the voltmeter with an electromotive force of .0005 volt, the total resistance of the circuit being about 360 ohms, we have, at most, a current of only $\frac{.0005}{360} = 1.39\text{x}10^{-6}$ ampere and an output of $.0005\text{x}1.39\text{x}10^{-6} = 6.95\text{x}10^{-10}$ watt, as the discharge rate of the battery.

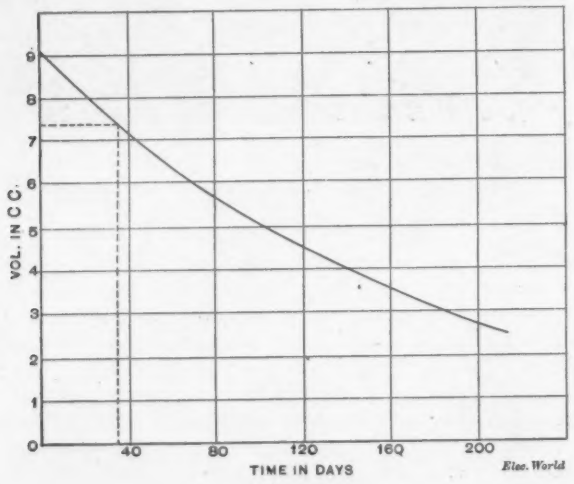


FIG. 2.

This means that a battery having a discharge rate of one watt would require about 1,440,000,000 such pairs of electrodes, or a total of 24,400,000 square feet of platinum foil .001 inch thick, or about 2,030 cubic feet of platinum! It is hardly worth while to calculate its weight.

Notwithstanding the small output of this cell, it was short-circuited and allowed to stand for five weeks to determine whether there was any alteration in the volume of the gases.

The volume of the hydrogen between the solution and the top of the platinum foil was about nine cubic centimetres, its weight about .0008 gram.

Assuming that we have a true voltaic cell consuming hydrogen and oxygen and capable of maintaining an output of $6.95\text{x}10^{-10}$ watt when the resistance circuit is 360 ohms, it will evolve its energy and consume its chemically active material more rapidly on a circuit of low resistance than on one of high resistance. This cell will, therefore, on short circuit evolve more than $6.95\text{x}10^{-10}$. But on short circuit the total resistance was only 6 ohms and $W = C^2 R$. Hence, the current is greater than $\sqrt{1.16\text{x}10^{-10}} = .0000107$ ampere. This current would consume 9 cm³ of hydrogen in about 89 days, provided the active surface remains constant.

But owing to the form of the cell the active surface of foil exposed to the gas diminishes as the volume of gas diminishes and (neglecting the surface of the small platinum wire) the solution would reach the top of the foil only in an infinite time. The curve in Fig. 2 shows the relation between the volume in cubic centimetres and the time in days of the discharge, on the assumption that at the beginning the volume is 9 cm³ and the current .00001 ampere.

An inspection of the curve shows that if the circuit were closed through a resistance of 360 ohms the volume of hydrogen should diminish to less than 7.4 cm³ in 35 days, or nearly .046 cm³ per day during this period. But as the cell was short-circuited it should have oxidized the hydrogen much more rapidly.

Four observations were recorded at the end of seven, eleven, eighteen and thirty-five days, as follows:

Seven days. Volume of gases unchanged. Circuit was opened and wires were connected to the voltmeter. Deflections were obtained exactly like those obtained on the first day of the experiment. Cell was again left on short circuit.

Eleven days. Volume of hydrogen apparently slightly increased. Volume of oxygen perceptibly diminished.

Eighteen days. Volume of hydrogen perceptibly increased. Volume of oxygen distinctly diminished.

Thirty-five days. Volume of hydrogen increased about 2½ per cent. Volume of oxygen diminished about 4 or 5 per cent.

In preparing to take a reading of the voltmeter, and before the volumes were marked, air was accidentally admitted into the tubes and no further observations were made.

The results obtained, however, are sufficient to show that the change in the volume of the gases was not such as would be produced by the combination of oxygen and hydrogen; but such as should be expected from the operation of Dalton's law of solubilities. Air would pass into the hydrogen tube faster than hydrogen would pass out, and air would pass into the oxygen tube slower than oxygen would pass out.

The conclusion, therefore, seems reasonable that the electrical energy of this cell, if there is any at all, is from some other source than the combustion of oxygen and hydrogen.

Influence of Carbons on the Candle Power of the Arc Light.

BY WILBUR M. STINE.

My attention has been called to a letter by Mr. B. H. Blood in your issue of March 9 on a recent article by the writer bearing the above title in THE ELECTRICAL WORLD for Feb. 23. He is entirely in error in the interpretation of the premises laid down in the article referred to. The argument throughout this article is based on the *luminosity* of the *electric arc* between *carbon points*, no reference being made to the light emitted by the incandescent ends of the carbons themselves. It was in this sense that the expression "the candle power of the arc lamp depends upon the amount of the carbon vapor which it contains" was employed. But the phrase "arc lamp" occurs toward the close of the article, after the main argument was established. It would, doubtless, have added much to the clearness of the article to have omitted the use of the term "lamp" altogether. Undoubtedly the expression is open to criticism, and has led to ambiguity of meaning.

Prof. B. F. Thomas, in the discussion of the paper by Mr. L. B. Marks before the N. E. L. A. at Cleveland, stated that at the usual angle of maximum intensity of illumination, 45 degrees, he had found a variation of over 50 per cent. in the candle power of carbons burned at fairly uniform watts. This is in confirmation of numerous tests already published, showing the influence which carbons exert on the candle power. In the original article it was the writer's aim to present some of the causes for this wide variation based on experimental data. In order to avoid going over ground already so well covered, attention was entirely directed to the arc itself, purposely excluding all reference to the incandescent ends of the carbons as sources of light. The knowledge on this subject is so full and generally known that it seemed useless to again present it. There was also an additional reason for this, as will be explained below.

The percentage of the total illumination which can be attributed to the electric arc alone is still an open question, and one on which

radically different opinions are held. It must evidently remain such until definitely settled by experimental evidence. A very notable paper on this subject was presented by Elihu Thomson in 1891, before the N. E. L. A. He then stated, "In regard to the ideas put forward as to the nature of the electric arc there is a wide divergence. These views are remarkable for their general inaccuracy or crudity, and have evidently been handed down with modifications. Few of those who have written about the electric arc, at least in the text books, seem to have had the courage to look at the arc, or they have 'seen it through a glass darkly, and not face to face.' It would require too many and lengthy quotations to give these various views. In most of them the light of the arc is attributed to intensely heated carbon particles transported by the current from one pole to the other. In most of them the *idea* of *carbon vapor* as a possible factor seems never to have arisen. Others attribute the arc to the heated air between the carbons which carries carbon particles, some of which are burned." Then follows a quotation in support of this statement (see original article in THE ELECTRICAL WORLD, February, 1891). To this may be added another quotation, "The light is produced by the incandescence of the carbons at the point of separation." * (a)

In this same notable paper Prof. Thomson points out the existence of what he termed "carbon vapor" in the arc, and attributed to it a considerable share in the production of the total illumination.

We find in the most recent authority on this subject the following: "It has been estimated that in the continuous current arc lamp 5 per cent. only of the total light emitted is due to the arc, a proportion of 10 per cent. is furnished by the negative carbon, and the rest, or 85 per cent., by the positive carbon." † (b) This, it will be noted, is only an estimated opinion, and is not based on experimental data.

If a number of carbons be burned under similar conditions, and they are looked at through colored glass, the arc will be seen to be decidedly more pronounced in some cases than in others, depending upon the conditions laid down in the original article. In some cases the arc is so pronounced in brilliance that it would seem to contribute more than 5 per cent. to the total illumination.

In the original article the term carbon vapor was employed in the same sense as used by many writers on luminous flames. The term vapor in its strict scientific sense means gas near the point of saturation. In its ordinary use it refers to matter in an exceedingly fine state of separation, approaching somewhat closely to the free molecular separation of a gas. In this sense the term is strictly applicable to the free incandescent carbon, which imparts the chief luminosity to flames, and which is equally applicable to the attenuated incandescent carbon in the electric arc. A highly luminous electric arc consists then of true gaseous carbon, but feebly luminous, and incandescent carbon vapor.

The electric arc when viewed through a glass is seen to be broader at the positive end than at the negative. It is so situated with reference to the crater, which *vicinity* is doubtless the chief source of light, that it would be more marked at the angle of 45 degrees than on the horizontal. There is reason to believe that its illuminating power, both at the maximum and horizontal points, is a larger factor, with proper carbons, than is usually admitted. It is, however, so difficult of isolation that its luminous value may be for some time longer only a matter of opinion.

No reference in the original article was made to the incandescent ends of the carbons for the reason that their variations in luminosity are mainly conditioned by the same causes which influence the lighting power of the arc itself. Here, as in the arc, the quantity and quality of the light depends upon the emissive power of the substance heated to incandescence. A poor carbon yields a blue, feebly luminous arc of gaseous carbon, whose emissive power is low. Then those conditions which enrich it with carbon vapor and increase its illuminating power will at the same time increase the emissive power of the carbon ends. It then matters little which side of the question is discussed since the results are the same in both cases. The main question of practical value is what quality of carbon will yield the highest total candle power. Should future experimental data not support this view of the influence of the arc on total illumination the conclusions as to the quality of the carbons must undoubtedly obtain.

Prof. Thomson also states the very interesting account which Davy himself gives of his classical experiment. Davy's description is as follows: "When pieces of charcoal about an inch long and one-sixth of an inch in diameter were brought near each other (within the thirtieth or fortieth part of an inch) a bright spark was produced, and more than half the volume of the charcoal became ignited to whiteness; and by withdrawing the points from each other a constant discharge took place through the heated air in a space at least equal to *four inches*, producing *a most brilliant ascending arch of light*, broad and conical in form in the middle."

* (a) Electric Light Installations. Salomons, p. 159.
† (b) Industrial Photometry. Palaz-Patterson, p. 234.

Electrical Condition of Buried Conductors Due to Leakage Currents from Electric Railways—III.

BY W. STUART SMITH.

The effect of a wire from track to pipe was occasionally seen at points outlying the line of the road where the passage of a car past a wired point would cause the pipe to become momentarily + to a horse or cable track which was normally + to the pipes. Those points are of no special interest, but a very important and peculiar region was that along the Mission street track from 14th to 24th streets. The Mission track had been prepared for use as an electric road, but the system was not then in operation. Before crossing the San Francisco & San Mateo track at 14th street the Mission track was + to the pipes, but as soon as 14th street was crossed the pipes along Mission street at once became considerably + to the track and continued so with varying readings, but never a reversal until about 24th street, when reversals began to occur, and at 26th street the track had again become permanently + to pipes, after which the potential of the track rapidly rose to seven or eight volts + to the pipes. This bonded track crossed the S. F. & S. M. track again at 29th street. It was much better bonded than the other road and formed a shorter path from the crossing at 14th street to the crossing at 29th than the S. F. & S. M. track. Moreover, the latter road was not bonded across a cable road on Valencia street, which consequently produced a total break in the ground circuit. Under these conditions it might have been expected that the Mission track would carry the current across the hypotenuse of the triangle formed by the S. M. road, and hence would be + to the pipes instead of the reverse, as was found. Measurements made at the crossing showed that there was several volts potential difference between the two tracks immediately at the crossing, showing no metallic connection between the two, and the dry dirt did not permit the passage of current.

A wire from S. M. track to pipes passed current to the latter and the current received down town would naturally tend to flow through the pipes in this region, thus raising their potential above the track as shown.

Another point of considerable peculiarity was at Valencia near 26th. There is a cable road on Valencia as far as the junction with Mission street, and this track was everywhere + to the pipe except for a short distance near 26th, where the water pipe was permanently + and gas varied ±. This is an isolated point in which the relations are the exact reverse of those found for long distances on both sides, and it is more peculiar, as it is not on the line of an electric road and hence cannot be explained by any consideration of wires to pipes and broken bonds in track. It seemed impossible to offer an explanation of this reversal, but a later study of the pipe systems gave the key. The explanation will be given when the second series of tests is being considered.

As it was known that the San Mateo road was heavily wired to water pipes at frequent intervals it was supposed that these pipes would be + to the gas pipes generally, unless the latter were also wired to track. As the gas was frequently found + to water it was at first supposed those pipes must also be wired, but as stated above this was found not to be the case.

It is generally supposed that water pipes are more liable to corrosion than gas pipes, owing to better conductivity, but generally both systems are practically of the same conductivity owing to the fact that the pipes cut no figure in the conductivity, this being entirely determined by the joints. In fact if there is any difference in conductivity it is in favor of the gas pipes (at least in San Francisco, owing to the generally smaller resistance of the joints). Though water pipes are no better conductors than gas pipes, yet as the former only were wired to track they might be expected to be + to gas, owing to the resistance between the two systems preventing free passage of current with consequent equalization of pressure.

Nevertheless, it is found that gas is as frequently + to water as water is to gas, showing that though one system may receive the

current from the track yet it is quickly divided between the two, how quickly is shown by the fact that gas is frequently + to water not more than half a block from a point where water is wired to track (even 50′ is sometimes sufficient to produce a reversal of relations). The study of the conditions beneath the surface shows that such distribution of current between the systems takes place because in many cases the mains in crossing each other come almost, if not quite, in contact, and the services from one system everywhere come very close to, and in some cases lie directly upon, the other main. Generally there will be two such service crossings (one from each system) in every 25′ or 50′, and thus throughout the entire network of pipes there are points of low resistance where current can pass from one system to the other. The effect is as though the systems were wired together at frequent intervals and the tendency is to equalize the pressure between systems and prevent a heavy passage of current at any one point on account of a small passage of current at many points.

That the current passing at any one point is small is shown by the fact that though many places were examined no signs of electrolytic action could be found anywhere. A certain minimum current is necessary to overcome the chemical affinity of the moisture or salts found in the ground, and if this amount is not reached no corrosion can accrue no matter what the potential may be. The fact that even when one system of pipes comes to a terminus and must pass its current to the other system the potential difference is generally not much greater than is everywhere found between the two systems shows how efficient the service crossings are in distributing the current between the systems.

The reason for gas pipes being + to the water so near a point where the latter is wired to the track is now obvious. When the current passes from track to pipe it is quickly distributed between the systems, and the greater drop of potential over the joints of the water pipes causes the gas to be +. Then the passage of current is the reverse way until a resisting joint in gas causes water to become +, and thus the see-saw of relation takes place throughout the entire area of influence.

The companies were advised that generally no danger need be feared on account of these potential relations, but if a point was found where service or main corroded on account of them the remedy would be to wire the systems together at that point. The distribution is so rapid that a wire from track to one system is in all respects equivalent to a wire to the other.

Mr. Farnham's original paper said the conductors were in a dangerous condition when they were + to the ground, and this is probably true with a conductor located, as was his telephone cable, so that the only points where current could pass were where it touched the ground in the manholes, but in these tests it was found that with the far more complicated conditions that exist in a network of conductors entirely buried in moist earth the results found do not warrant the assumption that a potential relation showing the pipes + to the ground is necessarily dangerous. Mr. Farnham found that in all places far removed from the power house with — of dynamos to rails the ground was + to his conductor, and, indeed, in the case of a conductor arranged as was his telephone cable, any other result was not to be expected, and even in the case of a pipe system forming conductors lying entirely in moist earth it might be supposed that where the track was + to the pipes ground would also be + on account of a passage of current from track to pipes through the ground, but these tests show that generally the contrary is the case, and in most places, except on the extreme lower reaches of a road or where one system comes to a terminus and passes its current to the other, the pipes are generally + to the ground whatever the relation between track and pipes may be. Of course if the test is made between the surface ground, near the track, and the pipe the ground will be +, but if the test be made between the pipe and the ground alongside the pipe is generally +, and in regions outlying the line of the road it makes little difference whether the ground contact is made 1′ or 100′ from the pipe, the pipe is generally + about the same amount at either distance and either towards or away from the power house.

The cause is evident when once the fact of drop of potential everywhere in the pipes is recognized. There is a continual tendency for the current to leave the pipes and pass through the ground to points ahead on the same pipe. Generally this current is far too small to have any possible effect, but if a very highly resisting joint was encountered in a pipe which was carrying considerable current a considerable potential difference might be set up between two points only an inch or two apart and very serious corrosion occur. The remedy would be to wire across the joint.

The ground tests were generally made by driving a bar into the ground in the hole dug to expose the pipes.

When the gas pipes came to dead ends and passed current to the water pipes the gas pipes were generally + to the water pipes and to the grounds, and in such regions water pipes were sometimes + to ground and sometimes —. If gas was + to water to any considerable amount the ground was apt to be + to the water pipe, showing the passage of an appreciable amount of current from gas to water. This was the case in all the region from one to two blocks west of Guerrero, from 14th street to 30th, the gas pipes only extending that distance west of Guerrero except along 18th street.

At the upper end of 18th street gas came to dead ends. Very generally water was + in that region during the first tests because the current entering the pipes must come down 18th and go south in order to reach the power house, and current entering water pipes would in part go to the gas pipes instead of the reverse, as is the case toward 30th street as above mentioned.

(To be continued.)

Action of a Single-Phase Synchronous Motor—II.*

BY FREDERICK BEDELL AND HARRIS J. RYAN.

The phase position of the motor with respect to the generator is represented exactly by the phase positions of their respective E.M.Fs. The relative phase position of these E.M.Fs. was determined by graphical construction, as in Fig. 5. The generator and motor E.M.Fs. and their resultant being known, their position is determined by a construction analogous to the parallelogram of forces. In Fig. 5, *ab* represents the direction and magnitude, taken in any convenient scale, of the generator E.M.F.; *ad*, the motor E.M.F., as taken from the magnetization curve; *ac*, the resultant E.M.F. The magnitudes of the E.M.Fs. being known, their relative positions are thus determined. The angle between the resultant E.M.F., *ac*, and the current, being determined as described above, *ag* may be drawn to represent the current. The diagrams, Nos. 1-22, are thus constructed:

The angle *bad* measured backward (or clockwise) shows the phase position of the motor armature with respect to the generator armature, and it should agree substantially with the disc reading of the phase indicator.

The energy in watts delivered by the generator to the circuit is equal to the product of the impressed E.M.F. (E) and of *ae*, which is the component of the current *ag* in line with the impressed E.M.F.

The energy in watts transformed into mechanical power by the armature is equal to the product of E' and of *af*, the component of the current *ag* in line with E'. This product must be negative in value, showing energy consumed and not produced, for the machine to run as a motor. The mechanical power developed is expended in driving the Edison machine on open circuit, and in journal friction, hysteresis and foucault currents. The iron losses increase as the field excitation in increased. The difference between the watts delivered and the watts transformed into mechanical power is equal to the RI^2 losses of the armature circuit. Thus from the fifth observation (see Diagram 5,) we have:

$$\text{Watts input} = 41.5 \times 3.85 = 160.$$
$$\text{Watts mechanical power} = 29.7 \times 5.0 = 148.$$
$$\text{The } RI^2 \text{ losses} = 160 - 148 = 12 \text{ watts.}$$

No measurements were made with a motor field current above six amperes, on account of the possibility of springing the armature shaft; it is to be supposed that the motor would run synchronously beyond this point.

The results are shown in Fig. 10, and in the diagrams Nos. 1-22. In Fig. 10, curve *C* shows the armature current for different field excitation; the current becomes less and less as it comes into phase with the impressed electromotive force, and then increases as it takes a position in advance of the electromotive force. That there is a point of minimum current and a maximum power factor has been shown by Mr. Mordey, in a curve like *C*, Fig. 10. Mr. Steinmetz has determined curves analytically, plotting them from a quartic equation, showing the relation between armature current and motor E.M.F. He assumes a constant reactance and the absence of armature reactions. His theoretical curve for no load (where no load means the absence of friction and of all energy expenditure)

* Condensed from the *Journal* of Franklin Institute, March, 1895.

meets the X-axis at a sharp point which would show that when the motor was doing absolutely no work the armature current would actually be brought to zero, for a particular value of the field current. His curve for light load corresponds approximately with curve *C*. It is, however, constructed for a constant load, whereas the load in the present investigation became greater as the hysteresis losses increased with the excitation.

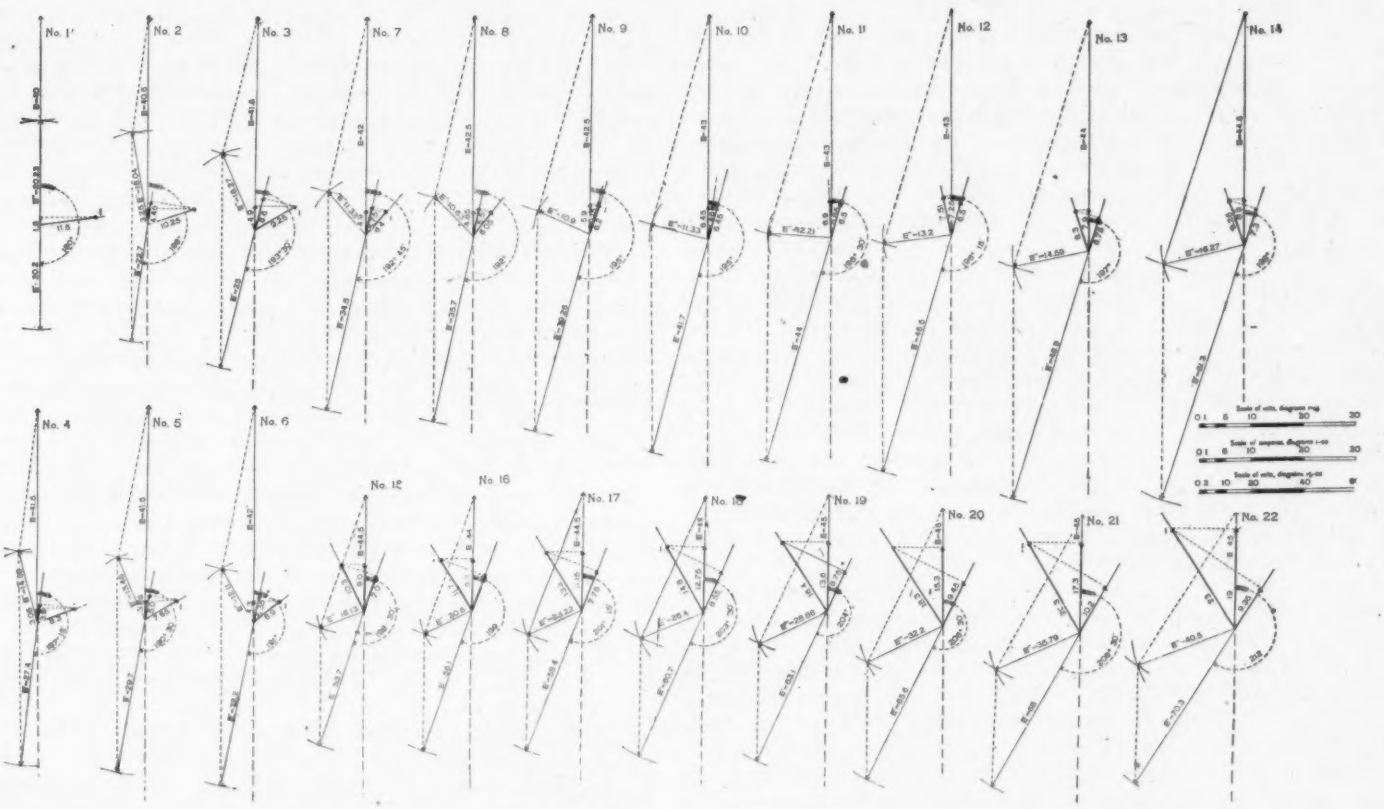
The increase in the generator E.M.F. on account of armature reactions, although the speed and excitation were constant, is shown in curve *D*, Fig. 10. That armature reactions have the opposite effect in the motor, as mentioned earlier in this paper, is shown by curves *F* and *G*, which represent, respectively, the E.M.F. observed at the brushes of the motor, and that obtained from the curve of magnetization. With a small field excitation, the armature current, which is a lagging current with reference to the generator E.M.F., is one of advance with reference to the motor E.M.F.; and the armature reactions are, therefore, such that the E.M.F. at the brushes of the motor is greater than that obtained from the curve of magnetization. With a larger field excitation of the motor, the armature current is one of advance with reference to the generator E.M.F., and a lagging current with reference to the motor E.M.F., which causes the E.M.F. at the brushes of the motor (curve *F*) to be less than that obtained from the magnetization curve, as shown in curve *G*. The rise in the generator E.M.F., due to armature reactions, corresponding to this decrease in motor E.M.F., due to the same cause, is shown in curve *D*, as already explained. These curves have not been corrected for the fall of potential due to the impedance of the armature; but the results are quite striking and are in accordance with the explanation given in the early part of this paper, to the effect that the armature reactions in the generator and motor assist in the self-regulation of the plant. The gradual change in armature lag is shown by curve *K*.

In diagrams, Nos. 1-22, the current, represented by the heavy arrow *I*, lags behind the generator E.M.F. when the field excitation of the motor is weak. The motor thus produces the effect of self-induction in the circuit.

As the excitation is increased, the current comes more and more into phase with the E.M.F., and finally comes into phase with it. The armature current is now a minimum. A further increase in the field excitation advances the armature current ahead of the E.M.F.; that is, the motor now acts the same as a capacity or condenser, in a circuit, this capacity effect increasing as the field excitation increases.

In a recent paper on "Some Advantages of Alternate Currents," Prof. S. P. Thompson lays particular stress on this condenser action of an over-excited synchronous motor, and emphasizes the fact that synchronous motors may advantageously be operated in parallel with transformers, to overcome the effects of self-induction. We have experimented at length upon the action of condensers in parallel with transformers, and the advantages to be obtained by this system of operation. Inasmuch as the transformer tends to make the current lag, and the condenser tends to place the current in advance of the E.M.F., it is possible to obtain such a balance between the two that the line current will be in phase with the electromotive force. Under these circumstances a certain amount of power is transmitted with a minimum current. The polar diagrams, in the present paper, show conclusively that the condenser action of over-excited synchronous motors will enable them to be operated in the same way as were the condensers in the paper referred to.

The changes in the magnitude and direction of the armature current, as the field excitation changes, are clearly seen in Fig. 11. The current for the first observation (compare diagram 1) for the weakest field excitation, has the position I_1. As the field excitation increases, it takes successively the positions indicated by points, coming into phase with the E.M.F., and finally in advance of it, as shown in the position I_{22}, corresponding to the last observation (see diagram 22). The heavy arrow I_8 represents the current for one particular observation. The locus for the armature current is obtained by drawing the curve through the successive points. With a constant E.M.F. the distance of any point of this curve above the horizontal would be proportional to the power given the motor. With a constant E.M.F. and constant power supplied to the motor, the curve would be a horizontal straight line. The rise in the curve at the left is due to the increased power, necessary in this case, as the field current of the motor is increased. The irregularity in the curve at the right is due to the instability of operation during the first few observations.



POLAR DIAGRAMS, NOS. 1–22.

In constructing the polar diagrams, the values of θ, the angle of lag of the motor armature, as obtained by the readings of the phase indicator, were not employed. From the diagrams constructed as described above, the value of the armature lag was obtained and agreed closely with the armature lag as shown by the phase indicator. The accuracy of the work and the correctness of the reasoning were thus completely verified by the phase indicator readings.

The polar diagrams, here shown for the first time, thus simply show the complete action of the synchronous motor.

Electrodynamic Machinery—XXX.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

154. During the rotation of the armature of a dynamo-electric machine through the flux produced by its field magnets, electromotive forces are not only generated in the conducting loops on the armature by the successive filling and emptying of its loops with flux, but they are also generated in all masses of metal revolving through the flux; in other words, the iron in the armature core and the copper of the conductors will be the seat of E. M. Fs. Though these E. M. Fs. may be locally very small, yet, since the resistances of their circuits are generally exceedingly small, the strength of the currents set up may be very considerable.

Such currents are generally known as *eddy currents*. They are necessarily alternating in character, their frequency depending upon the speed of revolution and upon the number of poles.

Not only is the energy expended in eddy currents lost to the external circuit, since they cannot be made to contribute to the output, but such currents also unduly limit the output of the armature, by raising its temperature, independently of the increase of temperature due to the passage of the useful armature current through the conducting loops. Losses of energy due to eddy current are of the type $I^2 R$ (in watts), I being the strength of the local current in amperes, and R the resistance of the local circuit in ohms.

155. It is evident that a dynamo machine can never be designed so as to be entirely free from eddy currents, for conducting loops must be placed on the armature, and in nearly all the types of practical dynamo machines iron armature cores are employed.

All that can be done is to reduce these losses as far as is commercially practicable. In the case of the iron core, for example, the advantage arising from its use, namely, the decrease in the reluctance of the magnetic circuit, can be retained, provided the material of the core is made continuous in the direction of the magnetic flux paths.

156 If a piece of metal be revolved in a magnetic field, it will enclose magnetic flux. A distribution of E. M. Fs. will be established in it according to the rate at which the enclosure takes place, and depending upon the shape of the piece. These E. M. Fs. will produce eddy currents in the moving metal. The rate of expending work in eddy currents will be in direct proportion to the conductivity of the material. A piece of revolving copper will have much more work expended in it by eddy currents than a piece of lead or German silver. If, however, we divide the mass of metal into a number of segments or smaller portions, the total E. M. F. at any instant will be divided into a number of parts, one in each segment, and the resistance of each segment to its E. M. F. will be much greater than the resistance of the entire mass. The energy wasted in the mass will therefore be reduced. For this reason the iron core of the armature is divided into sheets or laminæ, in such a manner that the sheets afford a continuous path to the magnetic flux, but no circuit is provided for eddy currents across the sheets. The magnetic flux is conducted through the entire length of the sheet, but the circuits of the eddy currents are all in the cross sections of the sheet. The division of the armature core does not, therefore, increase the magnetic resistance, or reluctance of the armature, but enormously increases its resistance to eddy currents.

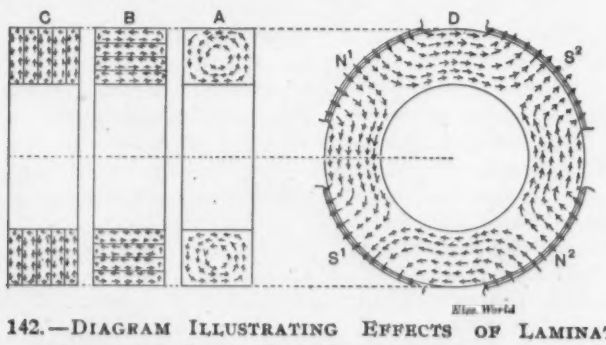


FIG. 142.—DIAGRAM ILLUSTRATING EFFECTS OF LAMINATING ARMATURE CORES UPON EDDY CURRENTS.

Fig. 142 represents at D, an armature core of solid iron capable of being revolved in a quadripolar field N^1, S^1, N^2, S^2; the arrows indicating the general directions of the flux paths. The cross section of the armature is shown at A, and the arrows represent diagrammatically the distribution of the eddy currents set up in the solid mass of iron during the rotation of the armature. At B, the cross section is represented with laminations parallel to the axis of the armature, as, for example, when the armature core is composed of a spiral winding of sheet-iron ribbon. Here the eddy currents are limited to the cross section of each band or lamina. The magnetic flux, however, has to penetrate all the discontinuities between the bands, in order to penetrate to the deepest layer, as shown in Fig. 8, unless the flux be admitted to the armature on its sides.

At C, the armature is laminated in planes perpendicular to the axis, or is built up of sheet discs. Here the eddy currents are confined, as in the last instance, to the section of each disc, but the flux passes directly along each sheet.

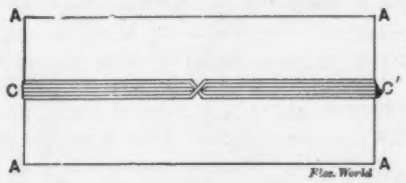


FIG. 143.—DIAGRAM INDICATING THE TRANSPOSITION OF A MULTIPLE ARMATURE CONDUCTOR.

While, therefore, the methods of construction indicated at B and C are equally favorable to the suppression of eddy currents, B, tends to increase the reluctance of the armature, and to magnetically saturate the outer layers of the core, with a corresponding sparsity of flux in the inner layers.

157. Taking a single lamina of the armature core, it is clear that if the intensity in the core is, say, 12 kilogausses, each square centimetre of cross section in the lamina is linked with 12 kilowebers, first in one direction and then in the opposite direction, as the armature moves from one pole to the next. The value of the E. M. F. round the cross section of the lamina, considered as a loop, depends upon the speed with which the linkage takes place, and, therefore, on the intensity (, the speed of rotation and the number of poles. The average E. M. F. in a lamina rotating at a given speed through a quadripolar field of intensity $\mathfrak{B} = 12{,}000$, would be four times as great as when passing through a bipolar field of intensity $\mathfrak{B} = 6{,}000$. The rate at which an E. M. F. of e volts expends energy in a resistance of r ohms being $\frac{e^2}{r}$ watts, the average wasteful activity in eddy currents depends upon the square of the speed of magnetic reversal in the core, and also upon the square of the intensity. If, then, we double the speed of revolution in an armature core, we quadruple the eddy-current waste of power. The higher the intensity of magnetic flux in the armature and the more rapid the reversal, the more important becomes the careful lamination of the armature, but the eddy current loss in armature cores is usually very small when the plates have a thickness not exceeding 0.02″.

158. As we have seen, eddy currents are not limited to the iron core of an armature, but are also set up in the conductors wound on the armature.

In this case eddy currents are set up in their substance by revolution under the poles, but the conditions differ slightly in detail. A Gramme-ring armature, for example, has no eddy currents set up in the conductors except upon the outer surface of the armature, since the flux passes through the wire at the outer surface and not through the wire on the inner surface. Similarly, a drum armature has no eddy currents set up in the wire upon the ends of the drum, if we may neglect such leakage flux as may pass through the ends of the core. Again, the amount of eddy-current loss will depend upon the distribution of the magnetic flux over the surface of the armature. If the flux entering the armature terminates sharply at the edge of the pole pieces, so that the wire suddenly enters or suddenly leaves a powerful magnetic field in the air gap, the rate of change of the flux enclosed in the substance of the wire will rapidly vary, inducing a brief, but powerful, E. M. F. in its substance, and the total expenditure of energy by eddy currents will be considerably greater than if the gradient of magnetic intensity in the neighborhood of the polar edges is less abrupt and the E. M. F. smaller in amount but more prolonged.

159. The eddy-current loss for a given size of machine is apt to be considerably greater with low pressure than with high pressure armatures, since the former require few massive copper conductors, while the latter require many separately insulated conductors. The plan is, therefore, frequently adopted of winding low-pressure smooth-cored armatures with multiple conductors, each main conductor being composed of a cable of separately insulated wires. Even when this is done, an additional precaution

is necessary, namely, to transpose the conductors or twist them through 180 degrees, half way across the armature surface, in order to prevent any pair of wires from acting as a loop for the generation of E. M. Fs. This is illustrated diagrammatically in Fig. 143, where the multiple conductor CC^1, consisting of five insulated wires, laid over the surface of the armature core $AAAA$, is reversed in the centre, so that the advancing wire at one end becomes the receding wire at the other, and vice versa.

It is sometimes found that the insertion of a sheet iron cylinder of the form outlined in Fig. 144, closely fitted into the polar bore, and

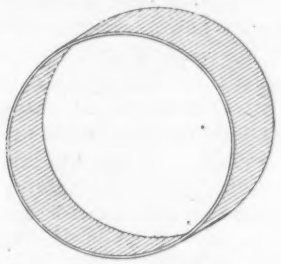


FIG. 144.—IRON CYLINDER OR BUSHING FOR FIELD CORE.

forming a tube within which the armature revolves, greatly diminishes the waste of energy in eddy currents.

This is for the reason that the edges of the pole pieces are removed, and the flux through the entrefer gradually varies between zero and full intensity as we advance round the field. The effective area of the polar surfaces is for the same reason increased. The objection to the introduction of such a cylinder lies in the magnetic leakage it introduces, for if A be the cross section of the soft iron sheet in square centimetres, the flux it will carry direct from pole to pole will be roughly 20,000 A, webers, and this flux has to be provided for through the magnetic circuit of the field frame in addition to other leakage and the useful flux through the armature.

160. When the armature conductors are buried beneath the surface of the iron, as, for example, when they run in the deep grooves of tooth-cored armatures, practically no eddy currents are produced in them, for the reason that the space they occupy is almost free from the flux established by the field. A tooth-cored armature may, therefore, be considered as an armature in which the eddy currents are confined to the iron laminæ of the core. This feature constitutes one of the advantages of tooth-cored armatures.

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(To be continued.)

A Large Electric Locomotive.

In the March number of the *Transactions* of the American Institute of Electrical Engineers is a description by Dr. Cary T. Hutchinson of a large electric locomotive which has just been finished by the Baldwin Locomotive Works. This locomotive has eight drivers connected rigidly by side bars, making a wheel-base of 16 feet, the length over all being about 30 feet. The weight is 133,000 pounds uniformly disitributed on the eight drivers, giving 16,700 pounds on each driver. There are four motors, one on each axle, the motors being built directly on the axle without springs of any kind between the armature and the axles. The machine has a capacity, on a four hour test, of 1,000 hp at a speed of 35 miles per hour. The regulation is the series parallel, the motor being: 1st, all in series; 2d, two series by two in parallel; 3d, all four in parallel. There is also a resistance intended for use on first position in starting. The lowest speed, without resistance, is about seven miles per hour.

A test recently made at the Baldwin Locomotive Works showed an efficiency of more than 92 per cent. when operating 1,000 hp. The motors are designed so that they will work without sparking with full current in the armature at one-half normal field strength. That is to say, they will operate at any speed from 35 miles per hour up to about 65 miles per hour at the same power, the drawbar pull varying inversely as the speed. At speeds below 35 miles per hour the drawbar pull is constant, the power, therefore, being directly proportional to the speed. The smoothness and absence of vibration was very noticeable in the test referred to. The entire machine was supported on four jacks, without bracings; when running with full torque, there was scarcely any shaking.

Electrical Power Transmission—XIX.

BY LOUIS BELL, PH. D.

Every electrical system has a definite period of oscillation determined by its particular properties. If we could apply an instantaneous electromotive stress to any point of it the effect would be that the resulting strain would travel back and forth with a definite frequency until its energy would be completely exhausted by doing work on various parts of the system. The action resembles that which takes place when we strike the end of a long rod with a hammer. An impulse is sent out at a rate depending on elasticity, density, and so forth, travels to the end of the rod, is reflected, and so goes on swinging back and forth until the energy is frittered away. This corresponds to electric oscillations on open circuit.

The two properties of an electrical system which determine its vibration period are its self-induction, which we have seen is analogous to inertia, and its capacity, which resembles elasticity in the dielectric, capable of taking up and returning energy. Resistance, like intermolecular friction in the rod just referred to, determines the rate at which the vibrations will die out by yielding up their energy to the system, but has ordinarily an almost negligible effect on the vibration period.

This period in an electric circuit is to a close degree of approximation given by the following formula:

$$T = .00629\sqrt{L\,C} = \frac{2\pi}{1{,}000}\sqrt{L\,C}$$

In this T is the natural time period of the circuit expressed in seconds, L is the coefficient of self-induction in henrys, and C the capacity in microfarads. For example, suppose we are dealing with a circuit of which the capacity is two microfarads and the self-induction one henry. Let it be arranged as in Fig. 29. For simplicity

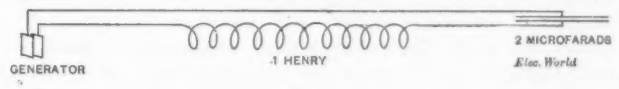


FIG. 29.

the inductance and capacity are shown localized and in series as would happen if a line ran through a group of series transformers and thence into a cable. If the line were open circuited beyond the cable we might find a very severe strain on the cable insulation. The period of this line would be .00887 second, about 113 cycles per second. If this should chance to be the frequency of the generator it would be in resonance with the line, and each wave of E. M. F. sent out by the generator will add itself to another wave just starting out in the same direction. A period later these two added E. M. Fs. would be reinforced by the next generator wave, and so on indefinitely.

The only thing which prevents the resultant voltage from rising indefinitely is the effect of resistance in causing each wave to die out gradually as it continues its oscillations so that only a limited number of waves can add materially to the resultant E. M. F. across the terminals of the capacity.

In a given circuit the relation between the initial voltage and the voltage of resonance can be easily determined to a fair degree of approximation. It is, neglecting minor reactions

$$E' = \frac{n\,L}{R}E.$$

In this equation E' is the E. M. F. of resonance, n the frequency, L the self-induction in henrys, R the ohmic resistance, and E the initial voltage. Applying this formula to the case just discussed and assuming the resistance of the line to be 15 ohms and the initial voltage to be 2,000 we find $E' = \frac{113 \times 1 \times 2{,}000}{15} = 15{,}066$ volts.

A very moderate line voltage may thus in a resonant line give rise to a pressure quite capable of rupturing any ordinary cable or causing serious trouble on an overhead line, to say nothing of greatly increasing the danger to persons and property. If the working pressure were 10,000 or 15,000 volts the E. M. F. of resonance might rise to an appalling amount.

Fortunately this theoretical value is in practice generally much reduced by hysteretic losses and Foucault currents in any iron-cored coils in circuit, waste of energy in the dielectric and other minor causes of damping the electrical oscillations, even when resonance

is complete. Still, dangerous rises in voltage are very possible. When the frequency of the applied E. M. F. differs somewhat from the natural period of the line, resonant effects can evidently still take place, but in a rapidly lessening degree; when the oscillations are strongly damped by the presence of iron the total resonant rise is generally diminished, but it varies less rapidly as the resonant frequency is departed from.

A resonance curve shows that the rise of voltage extends over quite a wide range of variation of capacity, but is large over but a small range. The shape of such a curve necessarily varies widely, as the resonance is more or less damped by resistance, iron-cored coils and so forth; but we may be quite sure that the maximum resonance will occur at not far from the point indicated by our equation for the vibration period of the circuit, and that the maximum E. M. F. of resonance will usually be somewhat less than that given by the theoretical equation.

(To be continued.)

Protection from Primary Voltage.

To the Editor of The Electrical World:

Sir: Noting the demand of your correspondent from Montana in your issue of March 23 for a particular device for use in conjunction with transformers I heartily recommend him to purchase modern types of transformers, most of which are so well designed and constructed as to insure him against the trouble he has experienced with the older types and render a protector unnecessary, providing the installation is made in a proper manner.

The writer had a protector made which was effective, consisting of an automatic main line switch, usually placed in the secondary as near the transformer as possible. This switch was opened by the action, when energized, of one or both of a pair of high resistance electromagnets, one being connected so as to ground through the magnet one side of the line, and the other the other side. By this arrangement a comparatively high resistance path is established to earth and across the mains of the secondary. With a magnet that was sufficiently energized to open the switch the leakage on a 50-volt circuit was about eight watts, and those used for 100-volt secondaries about 12 watts. This switch could easily be designed to put on a short circuit through earth as it is opened, and insure the destruction of the transformer or blowing out of primary fuses. With less than half the P. D. of the primary lines (1,000 volts), the switch operated instantly.

So much for a protector, but is it not much better to dispense with extra devices where possible? The money required to procure and install such devices had better be spent in overhauling old transformers and bringing them up to the present standard, or better, in buying new ones. Either one thing or the other will have to be done in the near future even with a protector. The improvement in efficiency of modern transformers over those made a few years ago will in many cases justify the change. I certainly will in all stations where current is maintained continuously on the lines.

Those who prefer to overhaul their transformers now in use which develop the trouble referred to will get the protection they seek in the type of transformers which have the primary wound over the secondary, by removing the primary winding, thoroughly insulating the secondary, preferably with several layers of micanite cloth, held in place by thin linen or similar fabric, being sure to have the outer surface of the secondary well covered with at least two thicknesses of the micanite and that it "break joints" in order to avoid a weak place where a puncture might occur.

The Thomson winding is decidedly the best for this type, and consists of winding the primary in two coils, side by side, on the secondary in such a manner that the two ends of the primary coil come on the outside. The vertical space between the two sections of the primary should be well separated by linen and micanite. To prevent lightning being conducted from the primary to the secondary where the windings are necessarily separated by but a short space, Prof. Thomson places half the winding of the primary so as to act as an effective choke coil between the outside primary line and the turns of the secondary coil.

In transformers where the primary and secondary coils are placed side by side careful insulation of each coil separately and a liberal use of mica between the two will give good results.

That great care should be taken to insure permanent separation of the wires leading from coils to cut-out, so as to have protection from accidental contact with the transformer case, as well as in completing the installation, is understood to be necessary. It is vitally essential that all parts of transformers accessible inside and out should receive the most conscientious inspection, and tested before being put in service, whether new or old.

New York, N. Y. J. I. Ayer.

Induction Alternators and Motors.

To the Editor of The Electrical World:

Sir: I have only just become aware of Mr. Dobrowolsky's interesting paper* on the new alternators of the Allgemeine Elektricitäts Gesellschaft, and wish to state that alternators of the type described have been built by the Stanley Electric Manufacturing Company under patents granted to Mr. Stanley and myself for a couple of years. The joint capacity of the generators now in service amounts to 7,500 kilowatts. I am glad to find our choice of a type confirmed by such a distinguished engineer as Mr. Dobrowolsky.

Even more interesting to me than the description of the alternators is the passage of the paper in which Mr. Dobrowolsky points out the magnitude of the lagging component of the current in induction motors, and its deleterious effect on the regulation of the generator. We have been calling attention to this for a long period, but we have been as one crying in the wilderness. The accession of such a recruit as Mr. Dobrowolsky is a great pleasure. The method of controlling the ill effects of lagging currents advocated by Mr. Dobrowolsky, the reduction of armature reaction to a minimum, is one as to which we are in hearty accord with him, and we have always insisted upon it. The only fault I would find with the method is that, while good, it is not sufficient. I hope yet to find Mr. Dobrowolsky an ardent advocate of the use of condensers.

I see by a later issue of the Elektrotechnische Zeitschrift† that I must also extend congratulations to Mr. Arnold, of Oerlikon, as a convert to the induction alternator. John F. Kelly.

Pittsfield, Mass.

The Blackening of Incandescent Lamps.

To the Editor of The Electrical World:

Sir: In Mr. Tolomei's article in your issue of March 30, on "The Blackening of Incandescent Lamps," I notice the statement that a microscopical examination of the deposit shows the presence of minute yellowish crystals, the chemical nature of which the author does not give. In view of the fact that most forms of fibre used in the manufacture of filaments contain some silica, it seems probable that these crystals are carbide of silicon or "carborundum." The conditions are much the same as in the furnace used by the Carborundum Company, where the reaction is $C + Si O_2 = Si C + 20$, the Si C being vaporized and condensing in the cooler parts of the furnace as yellowish semi-transparent crystals. If this reaction takes place in the incandescent lamp it of course leaves the free oxygen to attack the filament, thus further weakening it. Should further investigation prove this hypothesis to be correct, it would certainly suggest the importance of a fibre free from silica, or even perhaps the chemical treatment of the carbonized filament before mounting, in order to remove the silica. B. H. Blood.

Washington, Pa.

The Relative Values of Central Station Storage Systems.

In a communication received from Mr. Nelson W. Perry, a reply is made to certain strictures of Mr. Herbert Lloyd, contained in a note under the above caption in our last issue. Mr. Perry states that in the preparation of his paper read at the Cleveland Convention of the N. E. L. A., and criticised by Mr. Lloyd, all available information was gathered as to the original cost and expense of the maintenance of central station storage battery plants both here and abroad, and that most of his conclusions were based on figures given by the storage battery company of which Mr. Lloyd is the general manager.

Referring to Mr. Edgar's statement in regard to the battery plant purchased by the Boston Edison Company, Mr. Perry considers that Mr. Edgar's explanation was accepted by every intelligent central station man at the Cleveland meeting as proving that the only place for a battery plant in central station service is in taking care of the peak of the load line.

* See Digest, March 9.

† See Digest, this issue.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

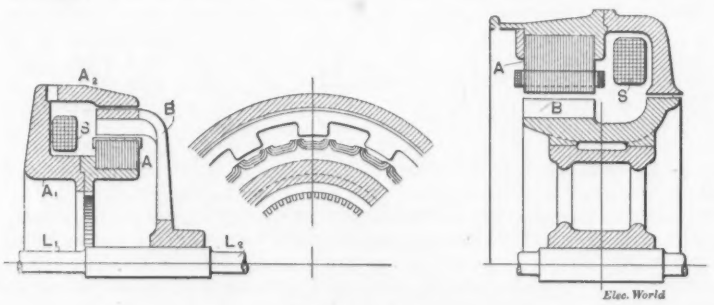
BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 922 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Unipolar Induction and Alternators with Stationary Windings.—A paper of some length by Prof. Arnold is reprinted in full with numerous illustrations in the "Elek. Zeit.," March 7. In discussing unipolar induction he refers to Faraday's views (Exp. Res., vol. I, §218-230), in which it is stated that the lines of force of a revolving magnet remain stationary; he describes some simple experiments consisting in revolving a magnet with and without a copper covering, the actions in all of which can be explained under the assumption that the lines of force revolve with the magnet; another proof is that if several parallel magnets are revolved together around a common axis the lines of force will evidently revolve with the magnet; he describes some further experiments. Under the assumption that the lines of force move with the magnets he discusses the various dispositions of the magnets in alternators, showing that the lamination need to extend only as far as the lines of force from the armature projections are not evenly distributed, and it is only in that part that hysteresis and Foucault losses will take place; he shows the advantages of enclosing the conductors partly or completely in iron and of using twice as many poles on the armature as on the field. He gives an illustrated description of the Klimenko machine and shows why the Mordey alternator, which is of this type, is a great improvement on it; in this, as in all the other types to which he refers, both the armature and the field magnet wires are stationary, the iron alone revolving; he discusses and describes various other machines of this type giving their advantages, among them he includes the Stanley machine. The fact that two continuous surfaces of a magnetic circuit can move relatively to each other without causing Foucault currents enables one to use a single field coil for multiple field magnets; to this class belongs the machine of Elihu Thomson; a still simpler arrangement is shown in the Thury machine, illustrated in Fig. 1, which will explain itself; of this form he speaks very highly including its mechanical construction; it is claimed that the good qualities of this machine are due to the favorable magnetic disposition; the small losses due to hysteresis and Foucault currents enable one to use a very strong magnetic field; the length of the magnet winding is less and therefore its resistance and self-induction are a minimum; the surface



FIGS. 1 AND 2.

windings of the armature give a smaller self-induction than windings in half or completely closed spaces; such machines may be easily connected in parallel and are especially applicable for running motors; the excitation requires only 1 per cent. and for large machines only ½ and ⅓ per cent.; the difference between the exciting current at no load and at full load does not exceed 5 per cent. for large machines; the efficiency is therefore 93 to 94 per cent. Fig. 2 shows an Oerlikon 60-kw machine in which the principle is the same, but it is carried out differently; it is specially suited for vertical shafts. He discusses theoretically the outputs of all alternators with single field exciting coil as compared with those having multiple excitation; he concludes that with the same induction in the air space the output of a multiple alternator with the same number of windings, width of pole, length of armature and surface velocity, will be the square root of two times as great as one having a single exciting coil; this difference, however, can with the same losses be equalized by higher induction in the air space, a slightly greater width of pole, and a greater magnetic induction, besides which a higher velocity is allowable, and for these reasons the two forms would be about equal; for multiphase alternators the case is different, the output of a single coil alternator can be made twice that of an equally heavy multipolar machine of the same efficiency and equally reliable. The smaller amount of radiation of the stationary coils is a disadvantage in this form. In practical construction single phase machines with a single coil will contain somewhat more iron and those with double (?) coils will be lighter, but for smaller outputs they are more expensive; with multiphase motors there will be a gain in lightness in both cases. His conclusions are that it cannot be denied that single coil machines are a great improvement both in simplicity and in reliability.

Niagara Dynamos.—In a communication to the Lond. "Elec. Rev.," March 15, Mr. Brown gives a brief illustrated description of the design which he submitted to the Niagara Company and enumerates his claims of priority. He claims to have had in view the idea of an exterior rotating field magnet which at that time he did not consider a novel feature of design and gives a reference of a published description in 'L'Ind. Elec.," May 25, 1892. The subject is also discussed by Mr. Hancock and Messrs. Fell and Wilding.

Regulations of Motors.—A system is described and illustrated in the "Elek. Anz.," Feb. 7, in which the field and the armature windings are double and so arranged that they can be variously connected by means of a convenient switch whereby the speed may be altered between wide limits without changing the position of the neutral axis, which would require an adjustment of the brushes.

Constancy of the Rotary Magnet Field.—"Elec. Power" for March contains an article by Mr. Rittenhouse; theoretical reasoning leads to the conclusion that a rotary magnet field should fluctuate in intensity; the article describes experimental investigations to determine this. Dobrowolsky claimed that his three-phased system was superior to the two-phased system of Tesla as these fluctuations were greatly reduced; others have maintained that theoretically such fluctuations do not exist; the fallacies in this reasoning as pointed out by Prof. Pupin are explained; that two harmonically varying forces differing by 90 degrees and acting at a constant point of application will produce a constant resultant is well known, but that two magnetomotive forces may thus be combined is not so evident; the parallelogram of forces cannot be applied to the discussion of a rotary magnet field; it has nothing to do with the resultant magnetomotive force; to establish this conclusion two rectangular coils were constructed, placed at right angles and having two-phased currents passing through them, the field being explored with a compass needle and also with a coil connected with a telephone; the principle of the conservation of energy has no connection here, nor is it a question merely of kinematics. He describes experiments made with the method of resonance analysis as suggested by Prof. Pupin which showed "that rotary magnetic fields produced by two and three phase machines exhibit no fluctuations whatever, and it would seem therefore that the theory maintaining their constancy has been substantiated; but since it has been shown that this theory starts with wrong premises it follows that the causes for the constancy of the rotary magnetic field must be sought, not in any theoretical considerations modifying the theory cited above, but in the assumptions from which thus far every theory has started." A distinction must be drawn between uniformity of rotation and that of intensity; theoretical fluctuations in the magnetomotive force are simply fluctuations in intensity and do not pass through zero, the magnetizing effect of which is totally different from that produced by an alternating current having the same mean value. Experience has shown that iron under ordinary circumstances practically maintains a mean value when subjected to pulsating forces, which is sufficient reason for the non-appearance of fluctuations in the magnetic induction of the rotary magnetic field, although fluctuations exist in the impressed magnetomotive forces.

LIGHTS AND LIGHTING.

The Electric Arc.—Mrs. Ayrton's paper is continued in the Lond. "Elec.," March 15. Altering either the current or the length of the arc changes the shapes of the carbons and the visible arc, in some cases very considerably; records of these changes were therefore taken after the arc had acquired its steady value for all different currents and lengths of arc they were drawn directly from the enlarged image of the arc; a large number of these are given. There is a white spot always present on the

top of the negative, the light from which is apparently quite as intense as that given out by the crater, although much less in quantity; the area of this bright spot increases with the current, but at a much smaller rate than the area of the crater. There are bright spots on the negative carbon which are either boiling carbon, tar or syrup used in the course of manufacture. From the set of drawings of the carbons it is noticed that in all the figures for short arcs of about 0.5 mm, the negative carbon is quite pointed, and as the arc gets longer the negative becomes blunter, thus the tip of the negative is more pointed the shorter the arc and the greater the current. The point depends on the carbons being nearer together and is believed to be caused solely by the carbon deposited from the positive; when the arc is very short and the current large enough to cause hissing, the deposit takes a mushroom form; the deposition is often rapid enough to cause the negative carbon to grow longer instead of shorter; with large currents the negative is somewhat more pointed but in a different way, it has no little extra tip on it and it is therefore believed to be due to the burinng away of the carbon; most of the heating of the negative takes place from the outside, and when the current is small the heat is small; with large currents, however, the tip is longer and more slender. The positive carbon tapers more with a short arc than with a long one for the same currents and has a longer but less pointed tapering part for a large current than for a small one. The positive carbon is consumed in two ways, by volatilization and by burning in combination with air; the former can only take place at or near the surface of the crater and therefore the shaping of the carbon must depend on the burning in combination with air; the positive becomes less pointed as the current increases because the tip burns away much faster than the sides; the point is longer, however, the larger the current because the increased amount of volatile carbon extends further up the sides; when the arc is short the volatile carbon spreads out farther causing the carbons to burn away farther than when the arc is long. In some additional illustrations of the carbon points it is shown what alteration will take place when the current is suddenly changed from a higher to a lower value or the reverse. Another set shows the arc with solid carbons, from which it is seen that the visible arc is larger with a solid than with a cored positive; in another set the positive carbons are solid and the negative cored showing that the latter burn away farther down than under the reversed conditions. Four large shaded drawings are given of the arc under different conditions, special attention being given to the outlines of the purple part, the shadow and the green outside part; the balls of boiling carbon are also shown. The use of cored positive carbons instead of solid changed the size and color, and in the long arcs the form of the visible part of the arc.

Alternating Current Arc Lamp.—A translation of the article abstracted in the Digest, March 23, is given in abstract together with the illustrations, in the Lond. "Elec. Eng.," March 15.

Incandescent Lamps.—Mr. Armagnat in "L'Ind. Elec.," March 10, makes some suggestions regarding the degree of incandescence of lamps. The luminous intensity of a lamp is the product of two factors, the surface of the filament and its intrinsic brightness; the ratio of these factors affects the quality of the lamps; he discusses the question of the degree of incandescence as defined by Mr. Crova, which he says may be taken as characteristic of a lamp, but it has not been proved that there is always the same ratio between the degree of incandescence and the temperature, when the nature of the filament varies, but as it is possible to determine this constant, it becomes a very useful quantity; he describes several methods by which it may be measured, one of them being with the aid of the Le Chatelier optic pyrometer which measures the brightness and not the intensity in candles; this instrument or one based on this principle may be used in studying incandescent lamps; it enables one to determine exactly the temperature of a filament and therefore its probable life. In the present lamp factories the standardizing of the lamps is accomplished by bringing them up to their candle power and measuring the volts and amperes; with the use of the pyrometer another method is possible, namely to bring the lamps all up to the same temperature and find the watts per candle power under these conditions; which of these two processes is the best he leaves for specialists to decide but he believes that it is best to define the temperature or the degree of incandescence.

Exhausting Lamp Bulbs.—A new patented process is briefly described in the "Elek. Anz.," March 10; the bulb is filled with a liquid such as a hydrocarbon, which readily boils at low pressures; the unsealed bulb is then placed in a vessel from which the air is partially exhausted which causes the liquid to boil thereby carrying the air with it; it is claimed that exceptionally good vacuums can thus be produced.

Automatic Lighting of Ships in Danger.—A system is described and illustrated in the "Elek. Anz.," March 10, in which magnesium lights are placed on the masts arranged so as to be ignited by a current from a dry cell through floating contacts placed in the bottom of the vessel and arranged so as to close if water enters the vessel; the circuit may also be closed by the officer on the bridge; the same circuit may also contain alarms.

POWER AND HEAT.

Electric Casting Process.—The Slavianoff process is described in a lecture by Mr. Lohmann abstracted in "Zeit. f. Elect. u. Electrochem.," Feb. 15, and in the "Elek. Anz.," Feb. 28. It is a system of fusion by means of the arc, like in the Bernados process only that both electrodes are of metal the movable pole being made of the metal which is to be fused; the arc which forms between the movable pole and the piece of metal to be repaired, causes the metal to melt and drop on the piece to be mended; a bank of some material must be made around the place where the metal is to be cast, to confine it to the proper limits. The advantages over the Bernados system are that as the metal is melted the process is applicable in a large number of cases; the efficiency is greater and the metal which is deposited is not so hard. In order to keep the arc the same length the movable pole, in the form of a rod, is adjusted automatically by the aid of a series coil which feeds it automatically. It has been in use for a number of years in Berlin. A commutator is placed in the circuit for changing the direction of the current; as the heat at the positive pole is about twice as great as that on the other, either one of the two pieces may be heated more than the other by a commutation of the current; with cast iron the commutation also has a chemical effect as the melted metal may be made a hard, a white, a soft, or a gray cast iron as desired; pulverized glass is placed on the surface to prevent oxidation by the air during the melting process, it is an expensive casting process but is applicable in such cases where the expense plays no part, as for instance in repairing a complicated casting or on board a ship; small castings may also be made in this way. A German railway company has used this system for repairing flywheels, steam cylinders, connecting rods of locomotives, etc. Some further information is given in the "Elek. Anz.," March 7; the current required is said to be about eight amperes per square mm of the metal electrode the diameter of which is made about six to ten mm; the metal should be heated first to a red heat in order that the drops of molten metal do not chill too quickly; in casting steel or iron, ferro manganese is added, which has the property of reducing iron oxide; copper and its alloys may also be cast by this process; with copper and steel the metal to be repaired is made the positive pole.

Treatment of Castings.—According to "L'Elec.," March 16, in the Wikstroem process the metal is cast in a slightly inclined trough enclosed in a vessel containing compressed air and a strong electric current is passed through the metal lengthwise, thus submitting it simultaneously to the action of the compressed air and the electric current which raises its temperature; what the objects are is not stated, but apparently the idea is to cool it slowly under compression.

Transmission of Power in Shipyards and on Board Steamers.—A paper by Mr. Wallace is abstracted at some length in the Lond. "Elec. Eng.," March 15; it deals with the transmission of power for comparatively small distances of 300 to 400 yards and in general with the advantages of driving machines in shipyards by means of electric motors; a table is given showing the power required for various tools used in shipyards; with electrical transmission 25 pounds of dry steam will give one electrical hp at the motor; the cost of fitting up a yard electrically should not greatly exceed the cost of the old system.

Transmission of Power in Italy.—In a communication by Mr. Azari in Lond. "Engineering," March 15, he states that three projects have recently received concessions from the government, one involving a waterfall of 47,000-hp., part of which is to be transmitted to Milan, another of 20,000-hp to be transmitted to Turin, and another of 7,000-hp to Biella.

Turbines for Electric Installation.—An illustrated description is begun in the "Elek. Anz.," Feb. 24, of several installations erected by a German firm.

Blast Furnace Motor Gas.—An article by Mr. Booth is published in the Lond. "Elec. Rev.," March 15.

Elastic Couplings.—A translation of the communication by Mr. Bablon, mentioned in the Digest, Feb. 9, is published in the Lond. "Elec. Rev.," March 15.

Friction of Belting and Shafting.—Mr. Woodward in a communication to the "Eng. Mag." for April refers to a statement in a recent article by Prof. Anthony (see Digest, Feb. 16), in which it is said that "the loss by friction of shafting and belting is constant whether the machinery it is intended to drive is in use or not." Mr. Woodward thinks he is justified in saying that this statement is incorrect and that while there is continual loss due to the shafting, the loss increases as the load on the machines increases and is therefore greater when the machines are running than is shown by the table and diagrams in that article; he gives a diagram showing the results of a test confirming these views; the increase in the sum of the belt tensions causes increased bearing pressure and increased loss by friction. To this Prof. Anthony replies that he meant that the losses were continuous and not that they were invariable, while in electrical transmission almost the whole of the transmission losses ceases with the stopping of the machine; he believes, however, that the pressure produced by a belt on the bearings is nearly independent of the load as the tension on one side diminishes as much as that on the other increases and he thinks, therefore, that the general statement is warranted that the friction of all belting and shafting that continues to run when the load is off is practically constant.

Water Powers of the Western States.—The "Eng. Mag." for April contains an article by Mr. Allan describing a number of water power installations and waterfalls in the Western States with the aid of a number of picturesque illustrations.

Power Distribution.—A brief abstract of the recent paper of Mr. Boucherot, mentioned in these columns some time ago, describing the transmission plant at the works of Weyher and Richmond, is published in the "Prog. Age," March 15.

Heat Distribution.—The Yaryan system of heat distribution from electric central stations is described and illustrated in the "Elec. Eng.," March 27.

Portable Storage Battery Outfit for Organ Motor.—An outfit is described briefly and illustrated in the "West. El.," March 30.

TRACTION.

Electric Railway Statistics for Europe.—"L'Ind. Elec.," March 10, publishes its third edition of the statistics for Europe up to the 1st of January, 1895; it consists of a long table published in the form of a supplement, containing tabulated data concerning each railway, and is the most complete summary which has been published. In the past year the number of lines has increased from 43 to 70, the length from 305 to 700 km, the power from 10,650 to 18,150 hp and the number of motor cars and locomotives from 538 to 1,236. Germany is at the head of the list with 366 km of tracks, the city of Hamburg alone having 180, France being second with nearly 100 km. Of the total number of roads 53 use the trolley system, three the underground conductor, eight the central rail, and four accumulators. The number of lines are distributed as follows: Germany 22, England 13, France 11, Switzerland 8, Italy 4, Austria 4, Belgium 3, Spain 1, Norway 1, Roumania 1, Russia 1, Servia 1. The largest amount of power is used on the City & South London line, 1,200 kw, the Liverpool line comes next with 900 kw; the maximum grade is 10.5 per cent. on the ordinary road and 25 per cent. on rack and pinion roads. There are no less than 28 lines under construction representing a total length of 200 kw. In conclusion a summary of the statistics of the previous year are given for comparison.

Transportation Across Rivers.—A system is illustrated and described in the "Elek. Anz.," March 3, which has been projected for traffic across a navigable river at Hamburg. It consists of a light, high suspension bridge, which forms the tracks from which are suspended cars which are slightly above the level of the water; these suspended cars are operated electrically; the bridge is high enough to allow sailing vessels to pass underneath; two cars are estimated to carry 6,000 passengers per hour in both directions and 40 to 50 carts and carriages, the transit being made in one minute. In case of a fog passengers can pass over the bridge by means of two elevators, there being no other approaches.

Suspended Railway.—The Mueller and Deitrich system, described briefly in the Digest, Feb. 16, is described and illustrated in the "Zeit. f. Elect. u. Electrochem.," Feb. 15; in this system the car is suspended from a single rail to one side of a point above its centre of gravity.

Electric Rudder.—A simple form which can be attached to any boat is described and illustrated in the "Elec. Eng.," March 15; the electric motor is connected to the propeller through a pair of bevelled gears; it weighs when complete about 45 pounds; with 85 pounds of accumulators the boat is said to run eight hours at a speed of five to six miles an hour.

Canal Towage.—The electrical system used on the Bourgogne canal, which has been fully described in these columns, is described briefly in Lond. "Engineering," March 15; the returns of the outlay are not very high, but it is stated that the plant is less troublesome to work than the steam tugs formerly used, and the speed is somewhat greater.

Light Railway.—In Dr. Preller's serial on electric cable railways in Lond. "Engineering," March 15, he gives a description with large illustrations, of the Stans railway, in which the trolley system is used.

Geneva.—The railway in Geneva is described and illustrated in "L'Energie Elec.," Feb. 16, including illustrations of the Thury motors.

Boston Subway.—A brief illustrated description of this subway through which street cars will pass in the crowded districts of the city is given in the "St. Ry. Gaz.," March 23.

Surface Contact Systems.—In the continuation of Mr. Sachs' article in "Elec. Power" he describes and illustrates a number of surface contact systems.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Central Station in France.—The table of summaries from "L'Ind. Elec.," abstracted in the Digest, March 9, is given in full in the Lond. "Elec.," March 15.

Paris.—Some of the statistics in the recent article in "L'Ind. Elec." regarding various companies in Paris are given in Lond. "Elec. Rev.," March 15.

Electrical Engineering in France and England.—Mr. Leonard's recent Institute paper is discussed editorially in the Lond. "Elec.," March 15.

Darmstadt.—A report of some length giving the operating expense and data of this accumulator station is published in "Elek. Anz.," March 3 and 7.

Zurich.—In "L'Ind. Elec.," March 10, Mr. Ritter gives a brief account with some data of the working of the station at Zurich.

Reducing the Cost of Electric Light.—In an article by Mr. Perry in the "Eng. Mag." for April he discusses some prevailing misapprehensions regarding the coal consumption and shows that at least one of the prolific causes of lack of economy in central station practice is the extremely variable load. "These increased costs due to variable load are not well understood even by those presumed to be fairly well posted;" he recommends storage and encouraging the use of currents during the daytime by reducing the price during those hours.

Municipal Ownership of Public Corporations.—The "Eng. Mag." for April contains an article by Mr. Francisco on this subject in which he strongly opposes municipal ownership.

Control of Public Service Corporations.—The "Eng. Mag." for April contains an article by Mr. Foote in which he advocates municipal control in preference to public ownership, participation in profits or franchise price.

Electricity as Applied to Mining.—The recent paper of Mr. Corlett read before the Northern Society of Electrical Engineers, England, is published in abstract in the "Eng. and Min. Jour.," March 23.

Life of Electrical Apparatus.—According to "Elec. Power" for March the Local Government Board of England, in connection with the subject of loans to municipalities, arrives at the following conclusions regarding the probable life of various electrical appliances: meters 5 years, accumulators 8, arc lamps 10, boilers and insulating mains 15, engines and dynamos 20, bare copper mains and culverts 40, and buildings 60.

Underwriters.—"Elec. Power" for March contains an article by Mr. Haskins on "Electricity, the Underwriter's Friend;" he describes the present condition of insurance regulation and inspection and urges the employment of better inspectors and better apparatus.

Inspection of Meters.—A copy of the bill introduced into the New York Assembly providing for electric meters and their inspection is reprinted in the "Elec. Age," March 23.

Loganspport Municipal Lighting Plant.—A description is published by Mr. Kammuyer in the "Elec. Eng.," March 27. It is a combined water power and steam plant and it is believed that it bids fair to prove a profitable venture for the city.

WIRES, WIRING AND CONDUITS.

Insulators in Conduits.—In an editorial in the Lond. "Elec.," March 15, the use of glass insulators in conduits and the fact that their use has been discontinued is referred to; it is stated that the positive and middle conductor quickly dry off any dampness, but this does not occur on the negative side where it is believed the condensation may exceed the dissipation. This selective action is not clear; no corrosion worth mentioning is found. Experienced engineers state that the positive and the middle will mend themselves but the negative will earth itself and will not mend; it seems possible that there may be a surface tension effect as in the Lipmann electrometer which causes the film of moisture near the positive to retract. It recalls an experiment of Lord Armstong's in which a cotton thread was placed so as to connect the water in two glasses; with an induction coil allowing only the break spark to pass, the water, if pure, will rapidly travel across the thread with the current, while the thread will move in the opposite direction. It suggests the possibility that the rise in insulation between two conductors on glass or stoneware is not due to electrolysis of moisture or to its dissipation by the heat so much as to this unexplained withdrawal from the positive and it may not be unaccompanied by any material rise in insulation at the negative.

Sodium in Electric Conduits.—The Lond. "Elec.," March 15, calls attention to an extract from THE ELECTRICAL WORLD, July 6, 1889, in which a case occurring in Boston with the Edison three-wire system is cited, and it is stated that the current had formed considerable quantities of metallic sodium throughout a mass of concentrated lye; "there was sodium enough present to make a fair display of fireworks when thrown into a pool of water." In the same issue a correspondent describes the conditions which he found by inspecting the scene of the recent explosion. Stoneware insulators are discussed by Mr. Fairfax.

Conduit Systems.—The Hoerde system, described in the Digest last week, is described with the aid of a number of cuts in the "Elek. Anz.," Feb. 10.

Renting House Wiring.—According to "Elek. Zeit.," March 7, the companies owning the central stations in Berlin have decided that they will undertake the construction of the wiring in private houses which are to be connected with the central station, at their own cost, the conditions being as follows: the consumer is to pay a rent which will cease at the end of ten years' use; the consumer binds himself for the payment of this rent for at least three years; he guarantees to keep the wiring in order and to insure it against fire; the consumer must obtain the consent of the landlord; he must agree not to use the wiring except for current from the station nor to allow others to use it; the company agrees not to remove the wiring as long as the rent is paid promptly and to allow it to remain after the rent has been paid for ten years; the rent will depend upon the number of lamps and is as follows: per incandescent lamp 75 cents per year, per arc lamp $2.50 per year, but the total must represent at least $15 a year; they will rent arc lamps for $2.50 per year; the rent for wiring for power must be determined for each special case. It is believed that this arrangement will meet with great favor.

Law Regarding Conductors.—The Lond. "Elec. Rev.," March 15, gives the substance of the bill recently discussed in France relating to conductors other than for telegraph and telephone purposes.

Paper as an Insulator for Electrical Conductors.—The article by Mr. Bishop (see Digest, Feb. 2) is continued in "Elec. Power" for March. He discusses the qualifications of paper for use in high potential conductors; he describes briefly the process of manufacture and gives the principal properties; it does not decompose by heat, is indestructible by dampness, time and electrolysis; it does not shrink or lose its pliability, is inelastic, almost incompressible and weighs from one-third to one-fourth that of rubber insulation; it is flexible and strong, but will not

bear the same amount of rough handling and pounding as a rubber compound, but no matter what treatment it receives the conductor will always remain concentric with the lead sheath; such cables depend absolutely on their lead covering for protection against moisture; the process of manufacture secures a uniformity throughout and is a positive security against admission of adulterating or harmful foreign matter; no case of a burn-out or blow-out has ever been known with such cables arising from causes inherent in its manufacture or material. He gives the electrical qualities which are as follows: No. 6 B. & S. wire, insulation .0156-inch not compounded with oils, insulation resistance 9,600 megohms for 650 feet, it broke down at 9,000 to 10,000 volts; after immersion for a day in boiling water the insulation fell to 33 megohms and it broke down at about 7,200 volts; a second cable was 1,200 feet long like the above and compounded with resin and resin oil; it had an insulation resistance of 4,070 megohms and could not be broken down with any voltage at disposal at the time; after immersion as before it fell to one third megohm and broke down at 7,500 volts; this shows that the ordinary galvanometer test applied to electric light and power cables or at least to paper cables is useless and misleading; the reason why rubber compound will give way is that it is not homogeneous and will expose weak spots even in the best made cables; the capacity of paper cables is about one-third to one-fifth that of other kinds, the cost is about one-third and the weight about one-third.

ELECTRO-PHYSICS AND MAGNETISM.

Energy Movements in the Medium Separating Electrified or Gravitating Particles.—A Physical Society paper by Prof. Minchen is abstracted briefly in the Lond. "Elec. Eng.," March 15. The object of the paper is to trace out the equi-potential surfaces and lines of flow for two electrified points or gravitating particles, and then to consider the paths along which the "energy cells" move when the charged points or gravitating particles either move toward or away from one another.

Electrification of Air.—An illustrated article by Lord Kelvin and Messrs. MacLean and Gault on "Electrification of Air and Other Gases by Bubbling through Water and Other Liquids" is begun in the Lond. "Elec. Rev.," March 15; it includes a number of illustrations of the apparatus.

Potential Differences between Metals and Electrolytes.—A paper by Mr. Rothmund from the "Zeit. Phys. Chem.," and abstracted in the journal of the Chemical Society, is noticed briefly in the Lond. "Elec. Eng.," March 15.

Capacity.—In the Lond. "Elec.," March 15, Dr. Silvanus P. Thompson discusses Prof. Nipher's views on capacity.

Waves and Vibrations.—The first of a series of lectures by Lord Rayleigh is abstracted in the Lond. "Elec. Rev.," March 15; he refers to waves in general but not in particular to electrical waves.

Multiple Resonance.—A paper by Mr. Bjerknes in the "Weid. Ann.," vol. 54, page 50, is abstracted briefly in the "Elek. Zeit.," March 7; the conclusions appear to be the same as those mentioned in the Digest, March 23.

Scientific Foundations of Electrical Engineering.—A paper by Mr. Baily is reprinted in the Lond. "Elec. Eng.," March 15; he discusses the accuracy of electrical measurements, the use of too elaborate hypothetical problems, etc.

Physical Work of von Helmholtz.—An abstract of a Royal Institution lecture by Prof. Ruecker is published in the Lond. "Elec.," March 15.

Spectrum of Argon.—The Royal Society paper by Mr. Newall is reprinted in the Lond. "Elec. Rev.," March 15.

Effect of Self-Induction and Capacity on Magnetism.—A paper by Mr. Fromme from the "Weid. Ann.," vol. 54, page 1, is abstracted in "Elek. Zeit.," March 7; he discusses the self-induction and electrostatic capacity of coils of wire and their effect on the magnetic properties; it is supplemental to the paper mentioned in the Digest, Oct. 13; the self-induction and capacity of a coil affect the magnitude of the "permanent moment" in opposite directions.

Permanent Magnets Used as Compasses.—The Lond. "Elec. Eng.," March 15, contains a communication from Mr. Smith in which he describes some observations which show that the variations in the deflection of a needle are sometimes due to peculiarities of the needle; he discusses a theory of the earth's magnetism.

What Is Electricity?—A few additional paragraphs forming a continuation of the article on this subject by the late Prof. Van der Weyde are given in the "Elec. Rev.," March 27; it was the last manuscript which he wrote.

Table of Magnetic Values.—A translation (without acknowledgment) of the article by Mr. Cushman mentioned in the Digest, Feb. 23, is published in "Elec. Power" for March; the original appeared in "L'Ind. Elec.," Jan. 25.

ELECTRO-CHEMISTRY AND BATTERIES.

Researches with Carbon-Iron Cells.—A short article by Mr. Schmitz in the "Elek. Zeit.," March 7, describes some recent experiments. Nitrate of potassium and sodium were melted in an iron crucible and a positive pole of carbon was inserted, the iron forming the other pole; carbons made of charcoal, anthracite coal and "gas coal" (bituminous?) should not be used as they ignite in connection with the saltpeter which wastes the greater part of the latter; the ignition takes place suddenly; the energy of combustion (?) may be increased by the addition of borax; with graphite there was neither a chemical reaction nor an appreciable current; the experiment with cored carbons was more promising, they do not ignite in pure saltpeter, even at 800° C., but at 400° to 500° there was a rapid evolution of the gas which increased appreciably on closing the circuit; the voltage was about one, and the current although small was constant; the carbon was the negative pole, therefore representing the zinc in the usual salts; the solution remained clear and the iron of the crucible was not attacked appreciably nor was there a deposit formed upon it; the evolution of heat due to the combustion of the coal was very slight and it was necessary to supply heat to the crucible, while with charcoal and gas coal the combustion of the carbon supplied sufficient heat to keep the electrolyte fused. It follows that the combustion of coal in saltpeter can be accomplished in two ways: like the combustion of coal in air in which heat is produced, and like the combustion of zinc in a battery in which electricity is produced; according to the constitution of the carbon the reaction will be mainly in one or the other of these ways; as the unnecessary consumption of the saltpeter in the second process is avoided there is a possibility of success in this direction.

Borchers' Battery.—The "Zeit. f. Elect. u. Electrochem," March 1 (edited by Dr. Borchers), in referring to the recent criticism concerning this matter, states that in his original article Borchers remarked that the results obtained cannot yet be considered favorable, but that they are sufficiently so to encourage further research, this statement is claimed to show clearly that further improvements were necessary but his critics, it is claimed, have judged his work from an entirely different standpoint.

Ferro Cyanide Accumulators.—Dr. Platner in the "Elek. Anz.," Feb. 24, describes some more or less successful experiments with such accumulators. The ease with which metals can be deposited from their cyanide compounds encourages an investigation of this subject. If a zinc and a carbon electrode are placed in the concentrated solution of pure ferri cyanide of sodium, then ferro cyanide of zinc will be deposited as a powder and ferro cyanide of sodium will be formed, but this system is not recommended as the solution is expensive and the deposit does not adhere well. Experiments with ferri cyanide of potassium gave no results as it contains free alkalis, but when these are precipitated with hydrofluoric acid the action at once begins; the same can also be accomplished by adding Turnbull's blue; the zinc deposit is much better than with the sodium salt; the voltage is 1.05 to 1.15, the maximum current density is 1.2 amperes per square decimetre; the voltage remains constant to the end of the discharge. He gives the complete chemical reactions in this accumulator. To prevent the zinc deposit from falling off the plate may be covered with some woven material. Experiments with corresponding manganese and cobalt compounds as also with other ferro cyanide metals give practically the same results.

Electrolysis of Gold.—An Institution paper by Mr. Keith is reprinted in the Lond. "Elec. Eng.," March 15; the first part is published in the Lond. "Elec. Rev." He speaks of the Rae process which has figured in recent patent litigation and states that it failed for two reasons, the imperfect knowledge of the inventor and the impracticability of causing the particles of gold to remain long enough in contact with the anode to be acted upon electrolytically; he gives the electrolytical equivalents and a general insight into the subject. Regarding the solving action of the cyanide solution he states that if a leaf of gold is placed on the surface it will readily dissolve, while if immersed it will dissolve but slowly, showing that the presence of oxygen is necessary; some figures regarding the dissolving action are given; methods of introducing oxygen are discussed; he believes the action of the oxygen is due to its strong electronegative relation to gold in a cyanide solution and he therefore tried various materials which are also electronegative, among them carbon, iron and mercury; the use of the latter improved the cyanide process; it is introduced by adding a small quantity of potasio mercuric cyanide at the rate of two ounces per ton of solution; he discusses this improvement at some length; the solution may be used uninterruptedly, the mercury simply facilitating the dissolving of the gold, the mercury itself being redissolved again; the solvent must be kept in motion through the mass; extremely weak solutions may be used. He describes the process in which gold is precipitated by means of zinc, also the electrolytic processes of Siemens and Halske recently described in a recent paper by Von Gernet which he discusses at some length, describing in detail the vat, which is made of wood, and the anode, which consists of sheets of iron, and the cathode, of sheets of lead; also the current density. He then describes his process in detail; from 2 to 10 pounds of cyanide are used for each ton of water to which 2 to 10 ounces of a soluble salt of mercury is added; the average current density is 0.06 ampere per square foot; the cathode is made of a copper amalgamated with mercury; between the cathodes are placed various cells filled with a half saturated solution of an ammonium salt such as chloride of sulphate, into which is placed zinc or iron connected to the other pole of the source; the required E. M. F. is not greater than half a volt; about 21 cents per ton can be saved by using this process. The "Zeit. f. Elect. u. Electrochem.," March 1, published some additional information regarding the Siemens and Halske process in the form of a supplement to the recent description of Mr. Gernet; costs and other data are given as also a comparison of this system with the MacArthur Forrest system.

Conductivity of Electrolytes.—A paper by Mr. Fanjung is abstracted briefly in the Lond. "Elec. Rev.," March 15; he determined the conductivity of various organic acids and salts at different degrees of concentration and at different pressures; he found that pressure caused a decrease in electrical resistance which, however, is not constant.

Electrolysis of Copper Sulphate.—A paper by Mr. Chassy from the "Comptes Rendus," vol. 119, page 271, is abstracted briefly in the Lond. "Elec. Rev.," March 15. He discusses the electrolysis of copper sulphate while hot, under which condition a violet red deposit is thrown down.

Laboratory for Electrolysis.—A description by Mr. Nissenson is given in the "Zeit. f. Elect. u. Electrochem.," March 1, of the laboratory for electrolytic operations connected with a metallurgical establishment in Germany.

Analyses by Electrolysis.—A paper by Mr. Classen, from the "Ber. der Deut. Chem. Gesellchaft," vol. 27, page 2,060, is recommended in the Lond. "Elec. Rev.," March 15; he describes how to fit up a model laboratory for chemical analyses by electrolysis.

Electrolytic Reduction of Aromatic Nitro-compounds.—A summary of different processes is given in the "Elek. Anz.," Feb. 24.

Kation.—In reply to the recent statement of Dr. Waddell (see Digest, March 23), Mr. Portheim in the Lond. "Elec.," March 15, shows that the word may just as well have arrived from another Greek word, and it should then be spelled "Kathion."

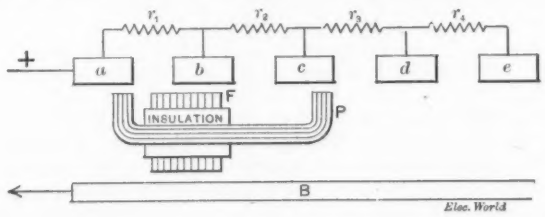
Aluminum.—Messrs. Blackwell, Sons & Co., Liverpool, England, in a communication to the "Eng. Mag." for April, state that aluminum will be made by a process of fusion at considerably less cost than can be done by the electrolytic process; it will be made from the Irish Hill bauxite very shortly at a cost which will "beat all competition."

Electricity Direct from Coal.—In a paper on this subject read at a recent meeting at the Franklin Institute by Prof. Bucherer, he showed that an important correction must be made in calculating the E. M. F. produced by the cold combustion of gases; that of the union of carbon monoxide with oxygen he shows is 1.406 instead of 1.476 as calculated directly from the heat of formation. The complete paper will be published in the Franklin Institute Journal for April; a full abstract is published in another column.

Electrolytic Reduction of Paranitrobenzoic Acid.—A paper by Messrs. Noyes & Clement, in the "Tech. Quart." for October (just received), describes the reduction product of this electrolysis which was found to be paramidophenolsulphonic acid.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Rheostats.—The Vedovelli system, which has been in successful use for some time, is described and illustrated in "L'Ind. Elec.," March 10. The object is to obtain a less sudden variation in the resistance of an ordinary step-by-step rheostat; with the present arrangement one obtains with n contact blocks the same number of steps in the resistance as with $(2n-1)$ blocks in the ordinary method. The device is shown in the adjoining figure, in which F is a contact block making connection with



the ends of the resistances a, b, c, d, e, and the rail B; the block F carries with it a bridge piece P, which, however, is insulated from it. In the position shown it connects block a with c, the current entering at a will therefore pass through the first and second resistance in parallel, leaving the block b through the contact piece F; in the next position on the right the bridge piece P will not make contact with any of the blocks and the current will then pass through the first resistance only; there will therefore always be one intermediate value between those which would be obtained without the bridge piece.

Photograph Photometry.—"L'Ind. Elec.," March 10, contains an article by Mr. Guillanne in which he discusses the hypothesis of Janssen based on the fact that the action on a sensitive plate is proportional to the illumination and the time of exposure and therefore to their product, the same effect would then be obtained when the product is the same; he shows from the experiments of Capt. Abney ("Proc. Roy. Soc.," vol. 54, p. 143) that this hypothesis of Janssen is based on incorrect assumptions; for very short exposures the action is less than proportional to its duration; regarding the illumination itself, below a certain limit the action decreases more rapidly than the excitation; prolonged action increases the capacity of the deposit less and less. He believes that it might be possible to introduce the necessary correction factors.

Apparatus for Measuring Phase Difference.—The "Tech. Quart." for October (just received) contains an article by Mr. Derr in which he describes an apparatus for measuring phase difference. In most methods it is assumed that the currents are sinusoidal but the present method is applicable to the measurement of currents of any form whatever and can be used under ordinary conditions. The apparatus is a modification of that of Dr. Puluj (described in Digest, Dec. 23, 1893, and Feb. 3, 1894) which consists of a pair of electromagnets each carrying a flat steel spring at the open end of its core, a mirror being mounted on the spring; a beam of light is reflected from one mirror to the other and thence on a screen; alternating currents are sent through the coils and the spot of light will form an ellipse from whose dimensions the phase difference can be calculated; the objections to this method are enumerated and are claimed to be overcome by the modified method devised by Mr. Derr. In this the two electromagnets are placed side by side and the two beams reflected from their mirrors are received on a revolving, prismatic mirror from which they are reflected on to the screen on which they will form sine curves which, however, bear no resemblance to the original wave form. A time lag of one wave behind the other will be shown by lateral shifting of the images, and represents the difference in phase; to measure it, the angle through which one of the magnets must be turned to bring the images together is measured, as also the further angle through which the same magnet must be turned to move one image laterally through one wave length, that is, until the wave apex o the one is brought to coincide with the preceding one of the other; the first value represents the portion of the wave length by which they are separated and the second gives the value for the whole wave length, the phase difference is therefore 180 multiplied by the ratio of these values, as the vibration frequency is twice that of the current. As these angles are small they are measured by the aid of a long pointer; metallic mirrors should be used in preference to those of glass, as the latter give double images; he gives the results of measurements of the lag between the branches of a three-phase circuit showing a good agreement with the theoretical values. The advantages of this method are: any source of periodic current may be used whether sinusoidal or not; slight changes in the E. M. F. do not affect the measurements; constancy in the speed of the revolving mirror is unnecessary; the approximate value of the lag and the quadrant in which it lies can be seen at once; the apparatus is simply and easily constructed.

Cable Testing Arrangement.—In the "Elec. Eng.," March 27, Mr. Loewenherz decribes and illustrates a convenient method, the object of which is to enable one to make capacity and insulation tests without changing the connections; the method is that of Mr. Thompson and is somewhat similar to that described in Mr. Webb's book on cable testing.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Automatic Telephone System.—The system of Messrs. Bonnard & Piat in which a subscriber can connect himself with any other without the aid of an operator at the central station, is briefly described and illustrated in "Elek. Anz.," Feb. 28; the number of subscribers does not seem to be limited.

Microphone.—The Mercadier & Anizan form described in the Digest, Feb. 2, is illustrated and described in the "Elek. Zeit.," March 7.

Telephone.—The Morlé & Porché system is described and illustrated in "L'Elec.," March 16. Several systems are illustrated and described in the "Elek. Anz.," Feb. 14 and 21.

Telephone Message Scale.—The "Elec. Eng.," March 27, discusses the recent statement that there is a protest against the new scale of charging of the Metropolitan Company and states that instead of there being a protest against it there is a rapidly growing feeling in favor of it.

Telephone Controversy in New York State.—A summary of the legislative contest is given in the "Elec. Rev.," March 27.

Long Distance Telegraphy and Telephony.—In "Elec. Power" for March Mr. Maver gives some reminiscences of early experiments in simultaneous telegraphy and telephony using the Van Rysselberghe system.

Microphone.—The Jacques long distance vibrating microphone is described and illustrated in the "Elec. Eng.," March 27.

Fire Alarm.—The Walter combined fire alarm and police signal system is described and illustrated in the "Elec. Eng.," March 27.

MISCELLANEOUS.

Purifying Carbon.—The following recipes are given in "Elek. Anz.," March 3, for carbons which are intended for arc lights, batteries and electrolysis. After pulverizing, it is mixed with chloride of potassium in the ratio of 18 to 1 of the latter after which concentrated sulphuric acid of 1.8 is poured over it at the rate of 2 pounds of acid to 11 pounds of graphite; it is important to avoid bringing in contact crystals of chloride of potassium with concentrated sulphuric acid as it will cause an explosion; the mixture is heated until vapors cease being generated; the chlorine generated will form soluble salts with the metals contained as impurities. The silicates are extracted by means of a fluoride of sodium. Electrodes which have lost their active property through long use can be rendered active again by this treatment except that they need not be pulverized. A similar but less effective process is to make the carbon plates anodes (that is connect them with the positive pole) in a concentrated solution of chloride of sodium and pass a current through them.

Educational.—The discussion of the subject of labor saving apparatus as an instrument of education is continued in the Lond. "Elec.," March 15, in a communication by Prof. Cornu, who may be taken as representing French physical science. His experience has taught him that there can be no such thing as abbreviated instruction, it must either be complete or it is not instruction at all; he shows the difference between understanding the nature of a voltmeter and the nature of a watch, time is not an unknown and complex idea like that of a volt; professors who wish to preserve "the old but good methods of instruction think it advisable to set their students to making galvanometers and suitable shunts without asking them to make either watches, weights or divided rules;" the technical professor considers that a voltmeter measures a

pressure, which idea is enough for him and he has no need to trouble himself about what a volt is. He discusses the apparatus in Prof. Ayrton's paper; the tendency which was felt by certain members of a physical society was that the character of technical instruction is condemned to drift farther and farther away from its point of origin and to abandon as useless for practical purposes the scientific bases which are the true foundation of practical applications. It is an error to think that there are two sources of instruction, one scientific and the other technical, one complicated and the other abbreviated, one addressing itself to the intelligence and the other founded on blind practice; he believes that there is only one method of instruction, that by which the student passes from the known to the unknown, from the simple to the complex, consisting in building up a new notion on an idea already familiar; that which distinguishes technical from scientific instruction in the nature of the arguments employed and the style of the proofs made use of; if under the pretext of being practical, simplification is sought at the expense of fundamental notions, the economy of time and trouble will only be apparent and often dangerous.

An article in the "Zeit. f. Elect. u. Electrochem." by Mr. Wilke recommends the introduction of techuical schools in which the student of electrical engineering can obtain that practical education which he now gets by serving some time in an electrical establishment, at the same time obtaining the necessary instruction in theoretical matters and drawing. The same suggestions are made in a paper by that author reprinted in abstract in the "Elek. Zeit.," March 7.

Lethal Effects of Electrical Currents.—A paper by Dr. Jones from the "British Medical Journal" is reprinted in the Loud. "Elec. Rev.," March 15; he discusses the subject of the fatal effect of electrical currents, giving the results of a number of observations, many of which have been described before.

Incubator.—An electrically regulated and heated incubator is described and illustrated in "Elek. Anz.," March 3.

Acetylene.—According to the "Eng. and Min. Jour.," March 23, another danger in the use of this gas was pointed out in a recent discussion in Manchester, Eng.; it was stated that the gas is easily decomposed by a shock, such as the firing of a percussion cap; the danger is increased very greatly when the gas is compressed into a liquid and stored in cylinders, in which form it has been proposed to use it.

Tesla's Laboratory.—In a short article in the "Eng. Mag." for April Mr. Martin discusses the nature and significance of the event of the burning of Tesla's laboratory; he mentions briefly that the most advanced form of the oscillator had been used to light the laboratory for months.

Transformer Efficiency.

The interest taken in the "Packard" transformer shown running with the case full of water at the Cleveland Convention of the National Electric Light Association will make further data on the subject acceptable to central station men and electricians in general. The water test clearly demonstrates the excellence of insulation. The efficiency test given below was made at Cornell University by Prof. Harris J. Ryan, and, of course, is absolutely disinterested, as well as of the highest authority.

Size.		Voltage.		Efficiency.				Regulation from full to no load.
Lts.	Watts.	Prim.	Sec'd.	Full load.	¾	½	¼	
30	1,500	1,000	50	94.7	94.2	92.4	87.0	2.1
100	5,000	1,000	100	96.5	95.8	95.4	90.4	1.7

The transformers tested were of the standard make of the Packard Electric Company, Warren, Ohio, and the results obtained are highly creditable to the manufacturers.

An Important Electrical Enterprise in Mexico.

An interesting and important electric power installation is now under construction for the Cia. Anonima de Transmission Electrica de Potencia, located in the State of Hidalgo, some 100 miles north of the City of Mexico.

The water is taken from the Arroyo de Regla, a mountain stream having a minimum supply of 1,500 cubic feet per minute. A natural rock dam at a point in the canyon impounds the water sufficiently to admit of its being diverted by a cut through the bluff into a canal, which follows mostly the contour of the mountain—a distance of one and one-half miles. This involved the cutting of seven tunnels, aggregating a total length of 1,200 feet through solid rock.

From the terminus of the canal the water is carried to the power station through 1,700 feet of 30-inch pipe, which affords a vertical head of 800 feet; the pipe is of varying thickness to correspond to the pressure at various points on the line, the lowest portion being made of steel three-fourths of an inch thick. The pipe line discharges into a receiver 40 inches in diameter by 75 feet long, with which the wheels are connected by lateral branches. This is made of flange steel plates three-fourths inch thick, tested to 700 pounds water pressure, and weighs upwardsof 50,000 pounds

The power station consists of five Pelton wheels, 40 inches in diameter, of capacities of 400-hp each; these are direct connected to the same number of 12-pole, three-phase generators running at a speed of 600 revolutions and delivering the current at a pressure of 700 volts. There are also two 24-inch Pelton wheels, speeded at 1,700 revolutions for running the exciters. The step-up transformers are wound for a ratio of 1 to 15, making the line potential a little over 10,000 volts at the generator end. There are three transformer sub-stations in which air blast transformers are to be used. Pelton differential governors are attached to each wheel for the purpose of regulation.

This station is to supply power to the mines of the Rio del Monte company—one of the most extensive mining organizations in the world, and employing upward of 8,000 men. The power is to be used for operating mining machinery, such as stamp mills, crushers, pumps, hoists, ventilators, etc. The mines of this company are said to be the richest in Mexico, and are located within a radius of 20 miles, the maximum distance of power transmission being 23 miles, and the mean distance about 18 miles. Various other mines in the vicinity will also be supplied with power from this station, and the city of Pachuca also furnished with light. A market for the entire power being thus afforded at highly remunerative rates, the financial success of the enterprise is assured; in fact, it is claimed that the entire outlay of some $300,000 will be returned to the company in two years' time, from the saving effected in fuel heretofore required in carrying on their various operations.

This enterprise originated with, and is being carried to completion under the direction of Senor R. M. de Arozarena, an accomplished engineer resident of the City of Mexico, and also a director of the company.

The Pelton Water Wheel Company, of San Francisco and New York, have the contract for the hydraulic part of the work and the Thomson-Houston International Company, of New York, for the installation of the electrical machinery. The plant is expected to be in running order in about 90 days.

The Reno Rapid Transit Plan.

The proposal of the Rapid Transit Commission to build a four track tunnel under Broadway has not only brought out considerable opposition from the owners of the sidewalk vaults, but has also set to thinking the various owners of pipes, electric subways, etc., whether or not it is going to be possible to make suitable provision for them in the proposed construction of the street's sub-surface. The plan suggested by Mr. J. W.

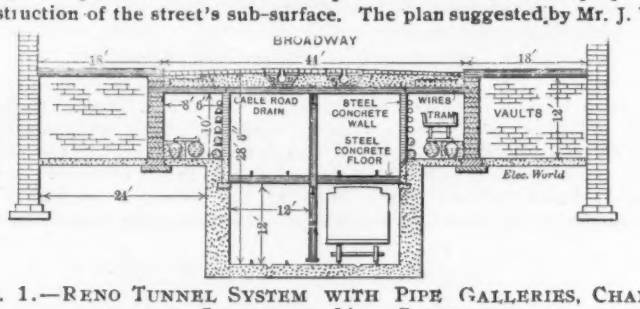


FIG. 1.—RENO TUNNEL SYSTEM WITH PIPE GALLERIES, CHAMBERS STREET TO 34TH STREET.

Reno, Mills Building, New York, as illustrated in the cut, proposes to avoid the condemnation of the vault area, which the commission estimates will add $5,000,000 to the cost of the line, and at the same time to furnish commodious pipe and wire subways in convenient position with reference to the buildings, so that the surface of Broadway will never in the future have to be torn up to admit of the making of pipe and wire connections or repairs to the same.

The electric wire subway is shown occupying space which otherwise would be useless, and by admitting of frequent access to the ducts from the pipe gallery beneath, will insure their always being dry and well ventilated. The unoccupied space in each gallery can be utilized as shown by a small electric "tram," which would be useful in collecting high class freight and express matter along the line and delivering it to the nearest stations.

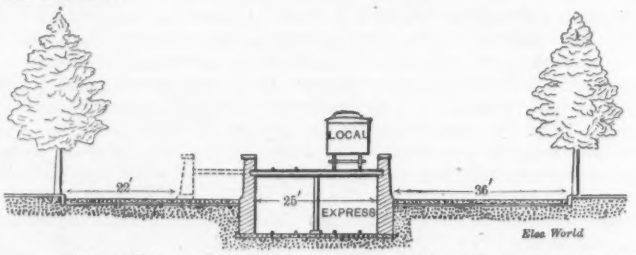


FIG. 2.—RENO PLAN COMPARED WITH "WIDE" PLAN, AT TUNNEL AND VIADUCT APPROACHES ON BOULEVARD.

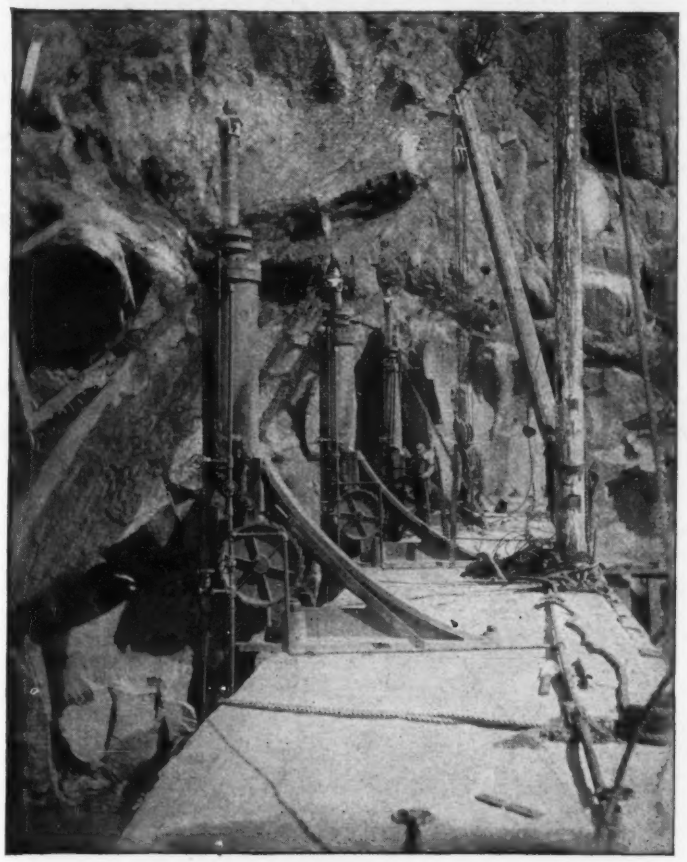
All these various conveniences ought to add materially to property values along the line and, if well known, would undoubtedly disarm any opposition of the property owners.

In the tunnel proper the local trains, whose platforms are only 12 feet below the street, will be carried, as shown, upon a substantial floor of steel beams and concrete upon which the rails can be suitably cushioned to prevent noise and vibration. The heavier and faster running express trains will, of course, have their road bed on terra firma, and at such a distance from the buildings that there will be no possibility of vibrations reaching their foundations.

Fig. 2 shows the simplicity of the Reno plan compared with the proposed "wide" tunnel at the 125th street viaduct approach, which latter plan would there be a serious encroachment upon the roadways.

The Sacramento-Folsom Power Transmission Plant.

The perfection of a system, by means of which power may be economically transmitted over long distances, and which suddenly



GATE MECHANISM.

broadened the field of critical effort, is now receiving practical and successful illustration in many places in this country, and our readers are familiar through our columns with the excellent work done at Taftsville, Conn.; Concord, N. H.; Hartford, Conn.; Columbia, S. C., and elsewhere. One of the best and most recent examples and one of the most interesting is the plant, nearly completed, which the Sacramento Electric Light & Power Company is constructing at Folsom, on the America River, where one of the largest water powers in California will be utilized. It is the more interesting in that the scope of the scheme, which at the commencement of the hydraulic work in 1866 was limited in its range, has been almost inconceivably widened by the alliance between water power and electricity which modern invention has brought about.

The work as at first conceived embraced a dam across the America River, near Folsom, and the utilization of the water, primarily for power purposes, and secondarily for the irrigation of the surrounding country. The plan was modest in its proportions, and remained so for many years, but the introduction of electricity immediately magnified it into a grand scheme contemplating the utilization of about 5,000 hp for transmission purposes, and 1,200 hp for use in the state prison located by the side of a special state power house.

The first step was taken in 1866 when the foundation for the dam was laid. Some years later the California state government contracted with the power company, and in exchange for water power privileges and certain grants of land for prison buildings, agreed to supply convict labor. In 1888 a new contract was effected, the size of the dam and canals as indicated in the original plans were greatly increased, and under these new plans the work, pushed forward vigorously, is now rapidly nearing completion. The dam is a massive structure of granite laid with Portland cement. It is 650 feet long, 89 feet high in the centre, 87 feet wide at the base, 25 feet wide in the crest, and contains about 48,590 cubic yards of solid masonry. It is provided with a heavy wooden shutter or flashboard six feet high, which at high water is lowered into a recess in the crest of the dam.

At each side of the dam is a massive granite bulkhead, in which are three head gates operated by hydraulic machinery, each head-gate being 16 feet wide. The West Side Canal is not yet completed, but is designed to be 40 feet wide at the top, 30 feet wide at the bottom, and six feet deep. It is intended principally for irrigation purposes.

The East Side Canal is completed from the dam to the site of the power house, a distance of about two miles. It is 50 feet wide at the top, 40 feet wide at the bottom, and 8 feet deep, having a capacity of about 87,000 cubic feet of water per minute. The canal is divided into three sections and follows the bank of the river for about two miles. It is constructed partly of masonry, partly formed by cuts in solid rock, and partly by earth cuts and fills. Just before it reaches the power house of the Sacramento Electric Light & Power Company it has been widened into an immense basin to hold the logs of the America River Land & Lumber Company, which company is about to erect at this point a large saw mill, to be operated entirely by electricity.

The power house of the Sacramento Electric Light & Power Company is situated at the extreme end of the canal on the west side of Folsom, where a fall of 55 feet is available at high water. Here an immense cut in solid rock has been made about 60 feet deep, 100 feet wide, and 150 feet long, from which a channel 40 feet wide leads to the river. In this cut the foundations for the machinery and the granite walls, piers and arches of a two-story building have already been laid, and the structure is progressing rapidly. At the power house the canal makes a sharp turn at right angles and widens out into a fore bay 150 feet long, 100 feet wide and 12 feet deep, forming a settling basin for debris. It is divided into two distinct parts by a wall provided with suitable gates so that one side may be cleaned out while the other is in operation. From the lower end of each section of the fore-bay a sluicing canal, normally closed by gates, leads to the lower river, and through this the sand and debris will be carried away and kept from the wheels.

The contract for the entire mechanical and electrical equipment was awarded to the General Electric Company in September, 1894. The contract for the hydraulic apparatus was let to the S. Morgan Smith Water Wheel Company. This apparatus will consist of four pairs of

VIEW OF DAM FROM BELOW.

McCormick horizontal-shaft turbine wheels, enclosed in steel cases having steel inlet pipes eight feet in diameter and double discharge tubes. The governors used will be of the Faesch-Picard type, and will be supplemented by heavy fly-wheels on the water wheel shaft. Each pair of wheels will have a capacity of 1,260 hp at 300 revolutions per minute. They embody all that is latest and most improved in hydraulic practice, and are of larger capacity than any hitherto constructed in this country, with one exception. They will be operated under a head of 55 feet. The hydraulic plant also includes two special horizontal wheels for the exciters. The water after having passed the turbines will be dis-

charged through tunnels under the power house into irrigation canals for distribution over the country south and east of Folsom.

The generators will be four in number, and of the General Electric three-phase alternating current type, furnishing current at 800 volts potential. The armature shafts will be directly connected to the shafts of the wheels by means of flange couplings. Each generator will have a capacity of 1,000 hp, and will weigh about 30 tons. They will be the largest three-phase generators yet constructed. The wheels and generators will be located on the first floor of the building 16 feet above the level of the water in the tail race, but will not occupy the same room. Between the wheel room and the generator room a heavy masonry wall has been built. The openings through which the turbine shafts will pass will be small, and the wall will serve to protect the electrical machinery from the possible entrance of water. The water wheel regulators will be in the dynamo room, and the operator will thus have full control of the hydraulic machinery while in sight of the electrical instruments on the switchboard. Both dynamo room and wheel room will be provided with traveling cranes.

In the second story of the power house directly over the dynamo room, sub-station step-up transformers will be installed, of the standard type used by the General Electric Company in such plants. In these transformers the E. M. F. will be raised to 11,000 volts, and connections to the line will be made through marble switchboards equipped with the necessary switches and fuses.

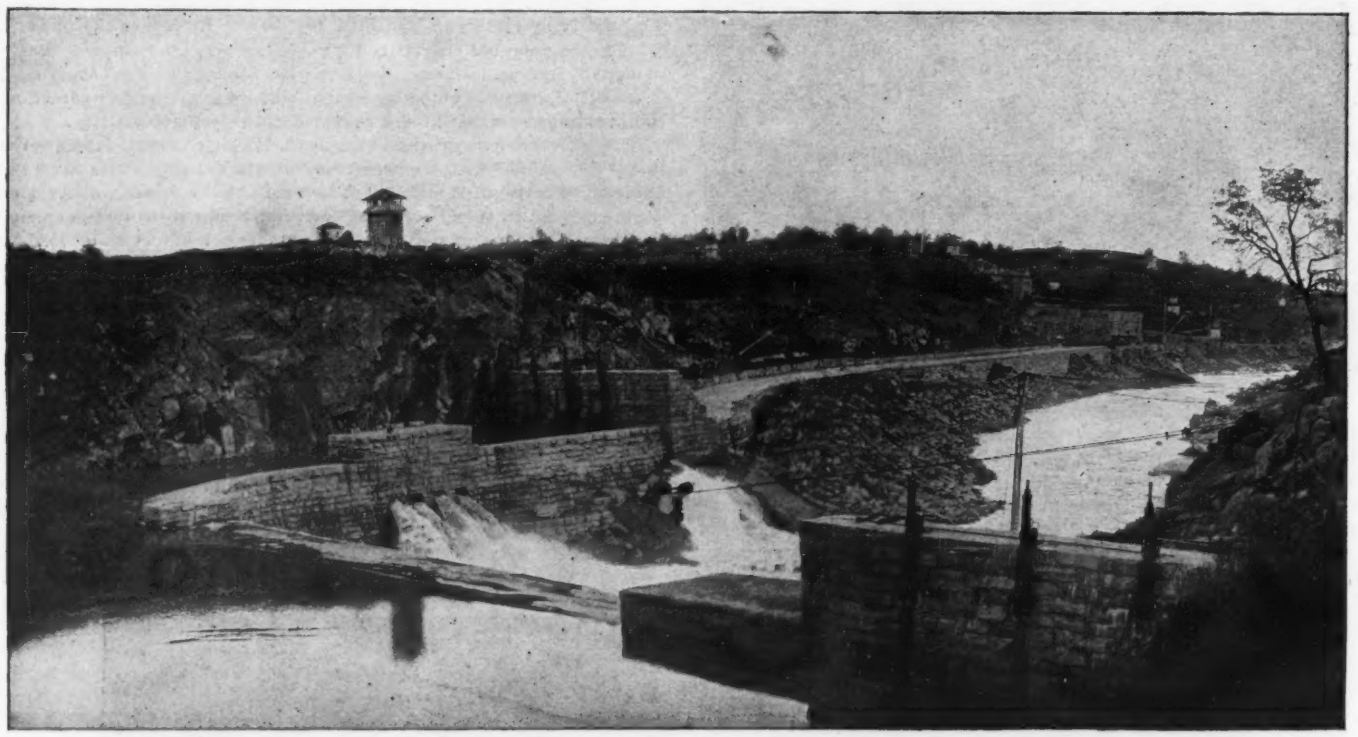
Special provision to prevent shut-down by accident or unforeseen contingency has been made in the pole line, which will be in duplicate from the Folsom power house to the Sacramento transformer sub-station, and will run along the line of the Sacramento & Placerville Railways as far as the city. For this purpose 2,600 40-foot round cedar poles, 16 inches in diameter at the butt, are used, and each will carry two cross-arms for the two circuits. Each circuit will consist of three bare copper wires supported on double-petticoat porcelain insulators especially designed and made for this installation at the porcelain factory of the General Electric Company, at Schenectady. Each insulator is subjected before shipment to a test of not less than 25,000 volts, alternating current. Each three-wire circuit can carry the output of one dynamo, and any dynamo can be thrown on any line, though they will all be normally operated in multiple.

The sub-station at the end of the transmission line will be a fireproof two-story brick building, divided into four parts, namely, the step-down transformer room, the motor, railway and arc dynamo room, the shop and testing room and the store room.

In the transformer room transformer switchboards will receive the terminals of the 10,000-volt transmission lines and enable the attendant to operate different combinations of the transformers. The step-down transformers, of the air-blast type, will vary in size according to the duty required of them, and deliver current at the secondaries at 125, 250, 500, 1,000 and 2,000 volts for incandescent lighting and motor service.

In the main room will be three 300-hp three-phase synchronous motors, of the standard General Electric type, directly connected to a line shaft. This shaft will be provided with clutch pulleys to drive several 500-volt continuous-current railway generators and a number of arc dynamos.

The incandescent lighting, commercial arc lighting and stationary motor work in the central portion of the city will be handled by a low tension modified Edison three-wire system, feeders from the secondaries of the step-down transformers supplying current to a network of mains. The motors will be of the three-phase induction type, and can be connected to the mains at any point. The street and private arc lighting will be done on the constant current series system, while outlying motors will be operated from higher potential lines with individual transformer reduction, or will be high potential synchronous motors.



View from Above Dam

A New Automatic Engine.

We illustrate in the accompanying engravings a new automatic four-valve releasing gear engine now being placed on the market by the Rice & Sargent Engine Company, Providence, R. I. Fig. 1 illustrates a 20x42-inch engine recently built for a Pawtucket (R. I.) manufacturing company, and Fig. 2 shows in cross section the valves, which are of the Corliss type.

Much care has been spent in the design to make all the parts heavy and strong in order to meet modern requirements. The bed-plate is designed with box sections. The guides are bored and the end of the bed-plate faced to fit the cylinder at one end of the boring bar, the guides and pillow blocks having broad foundation bases. The shaft is extended through the out-board pillow block in order to permit the engine to be converted into a double engine or cross-compound later on when increase of load requires. The pillow block is fitted with four-part full babbitted boxes with wedge adjustments for the side boxes and chain oilers for continuous lubrication. The greatest of care has been exercised throughout to maintain efficient lubrication. The connecting rod has a phosphor bronze box at the cross-head end, and full babbitted boxes at the crank end, the adjustment being provided for by wedges and screws at both ends, thus preserving the length of the rod constant under wear. The cross-head end is of the solid end type and the crank end fitted with a block and bolt on the lower side to facilitate the removal of the boxes. The cross-head is of the box pattern with babbitted ends and gibs and wedge adjustment.

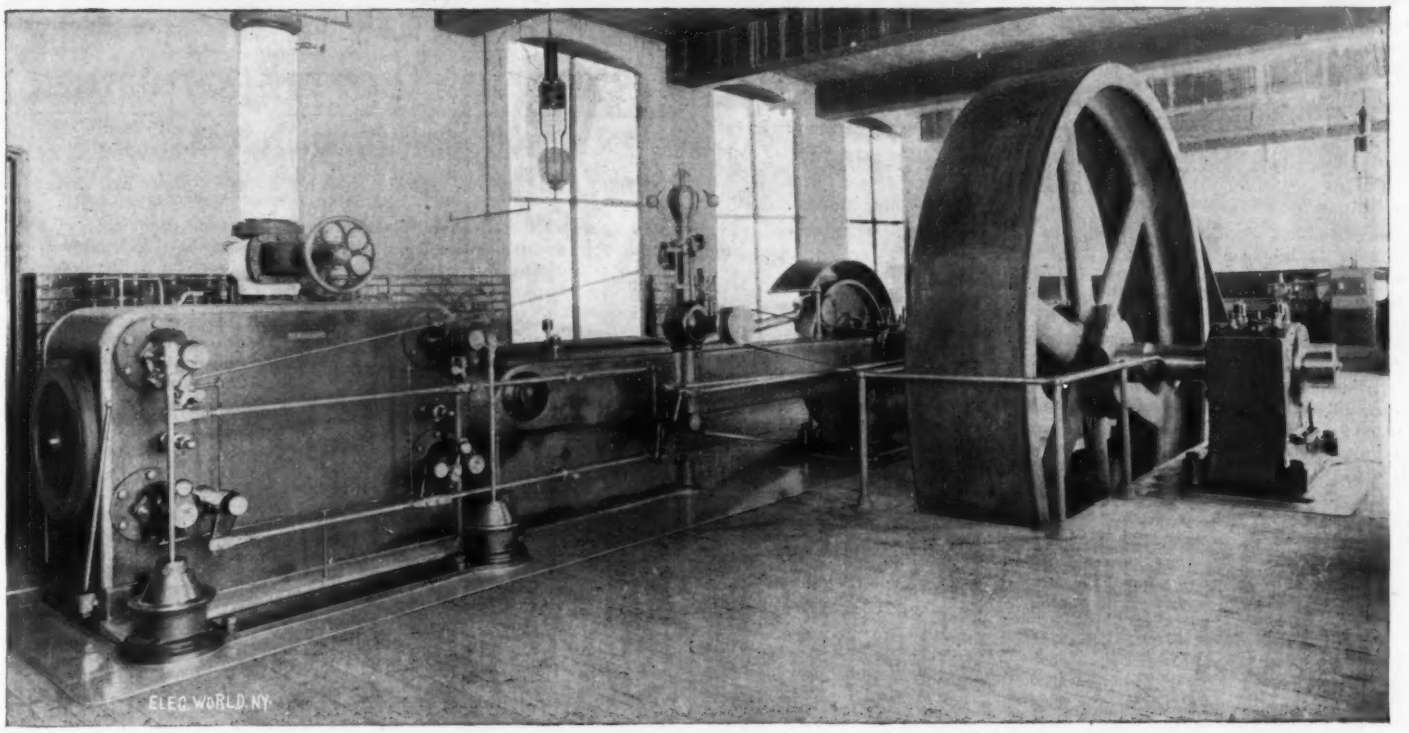
The cylinder is provided with four double-ported Corliss valves as shown in cross-section in Fig. 2 and with steam or exhaust chests, the latter being separated from the barrel of the cylinder by an air space to prevent cylinder condensation. The exhaust valves are brought well up into the cylinder so as to reduce the clearance.

The valve gear is a new form of releasing gear having separate eccentrics for the steam and exhaust valves, thus enabling a ready adjustment to be made suitable for any condition of running. The cut-off, controlled by the governor, has a range from zero to three-fourths stroke. The exhaust valve arrangement obtains the wrist-plate motion directly on each bonnet without the use of a separate wrist-plate, and also brings less strain upon the exhaust bonnets.

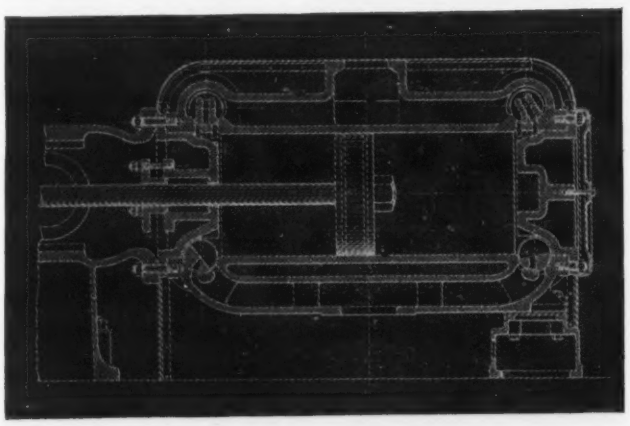
The steam valve arrangement consists of a rocker journaled on a fixed bushing projecting from the bonnet, which bushing surrounds and carries the valve stem. A regular rocking motion is imparted to the rocker by means of a link which connects a pin at the lower end of the rocker to the eccentric. The rocker is provided, about midway of its length,

with a bearing hub for holding the driving toe, the hub being cut away to provide for the forwardly projecting portion of the driving toe, and to allow the free vibration of the same on its pivot. A pivot spindle, forming part of the driving toe, has a free fit in the hub and passes through to the rear, and at the rear end of this spindle is keyed the cam lever, which is carried obliquely upward behind the rocker, and is a free fit between two rollers which are held upon the pins projecting in front of the trip lever, the latter being pivoted on the bonnet, concentrically with the valve-stem, and provided with an arm which is connected by means of a link to the governor. The valve lever is keyed to the valve stem and has a branch arm carrying the pin from which connection to the dash-pot is made for closing the valve. The valve lever projects downward at an angle of about 45 degrees, when in mid-position, and carries from a lug in the rear, a latch, which is engaged by the driving toe of the rocker, to open the valve. The latch is held in its position by its own weight, the front portion of the latch resting against the face of the lug and receiving the thrust of the toe for opening the valve. The upper part of the latch extends backward over the lug and is provided with a cylindrical turning point or pivot, on which the latch may be raised when the driving toe passes under it on the return movement of the rocker. The centre of the pivot of the latch is considerably above the line of pressure on the latch, so that the latter will be prevented from rising while at work, and a large amount of wear on the engaging surfaces has to take place before the latch can jump out of its engagement. This is an important feature of the gear, as by it the builders are enabled to use a light gravity latch, without the use of springs, and at the same time the latch is automatically locked in place when at work. The cam lever has a short incline about midway of the length of the cam, thus dividing it into two parts, each of which is a segment of a circle, so arranged that its centre will coincide with the centre of the valve stem when that segment is held between the rollers; so that in operation there will be no change in the relation of the cam lever and the attached driving toe with the rocker, except when the incline of the cam passes between the rollers.

At the beginning of the forward movement of the rocker the outer portion of the cam lever will ordinarily be between the rolls and the driving toe raised to its engaging position with the latch. As the rocker advances and opens the valve, the incline of the cam enters between the rollers, causing the driving toe to be depressed sufficiently to release the latch, and the valve is immediately closed by the dash pot. On the return movement of the rocker the incline of the cam returns between the rollers and raises the toe for subsequent engagement with the latch, and as the toe comes back to its first position the latch is raised by contact with the upper side of the toe and then drops in front of the toe for engagement again.



A NEW AUTOMATIC ENGINE.



SECTIONAL VIEW OF CYLINDER AND VALVES.

It is obvious that the angular position of the trip lever, which is controlled by the governor, will regulate the amount of opening of the valve and the proportion of the engine stroke when steam is admitted to the cylinder. Both latch and toe are provided with hardened steel plates, each with eight edges which are available for wear.

The governor, of the well-known high speed Porter type, runs at a high velocity and is extremely sensitive. Connecting rods from the governor to the valve gear are taken by a yoke with pins on both sides, so that all strains on the governor will be central and cannot cramp the same. The yoke also connects to a controlling vessel for steadying the governor, and weights may be added to change the speed of the engine while running. A "stop motion" is provided, which will immediately stop further admission of steam to the cylinder if the governor should be disabled.

The dash-pots are a new form of vacuum pot. They have a constant internal displacement and do not take in or discharge air at each stroke, and they are absolutely noiseless and free from vibration when cushioning.

A new form of rotary clutch for disconnecting either set of steam or exhaust valves, for operating by hand, is used. This consists of a steel tube with a long slot on each side containing notches which fit corresponding teeth projecting from the valve rod inside. The tube is rotated by a ball handle, the weight of which holds the clutch in or out.

The Lombard Water Wheel Governor—A Correction.

In our description last week of the water wheel governor manufactured by the Lombard Water Wheel Governor Company, Boston, a typographical error caused the last sentence of the article to read "Under a variation in load from 57 to 76 hp in one minute the speed of the water wheels is reported as varying $2\frac{1}{10}$ per cent." This should have read, "Under a variation in load from 57 to 446 hp in one minute, etc." A glance at the diagram would at once disclose the discrepancy between the statement in the text and the actual performance of the governor. By referring to the curve it will be seen that the variation in speed for average changes in load runs about $\frac{8}{10}$ of 1 per cent. which is much better than steam engineers are willing to guarantee for engine governors. It is perhaps superfluous to say that the case considered was an abnormal one, the selection being made with a view to showing the efficiency of the Lombard governor under the most unfavorable circumstances.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 30, 1895.

ELECTRICAL STOCKS reacted slightly this week, General Electric having declined 1¼ and American Bell 5. The report concerning an understanding between the Westinghouse and General Electric Companies as to patents and market prices has not been contradicted, and belief in its authenticity has taken firm hold. It is said that the patent litigation of these great corporations has aggregated $1,000,000 per annum recently, and that the abolition of this means an increase in net results of over 2 per cent. on the combined capitalization.

EDISON ILLUMINATING, of New York, will shortly provide for needed extensions of business by the authorization of a consolidated mortgage securing $15,000,000 of 5 per cent. bonds. Of this amount $4,312 000 will be used to retire first mortgage 5s now afloat. The new mortgage will provide that the total issue of bonds shall at no time exceed the outstanding volume of stock.

METROPOLITAN TRACTION declined sharply, contrary to the predictions of its friends that an advance was to be expected. This is ascribed to large speculative holdings that come on the market with every rally of a few points, for which there is considerable "gunning." There is nothing unfavorable in the operating results to justify a drop; the earnings are increasing right along, and a fine outlook for larger receipts is reported.

	Par.	Bid.	Asked
ELECTRICAL STOCKS.			
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	96¾	97½
" " " Brooklyn	100	..	108
" " " Boston	100	..	..
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	..	30½
General Electric	100	35⅛	35⅝
General Electric, pref	100	..	70
Westinghouse Consolidated, com.	50	35½	36
" " pref	50	52	52½
BONDS.			
Edison Electric Ill., New York	100	..	106⅝
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼
TELEGRAPH AND TELEPHONE.			
†American Bell Telephone	100	..	192
American District Telegraph	100	..	45
American Telegraph & Cable	100	89¾	91¼
Central & South American Telegraph	100	117	120
Commercial Cables	100	130	140
Erie Telephone	100	51	51½
Gold & Stock Telegraph	100	105	..
New England Telephone	100	71	72
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63⅛	..
Western Union Telegraph	100	88⅝	88⅞
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	15¼	15⅜
Binghamton RR. com	100	100	..
Brooklyn Traction	100	9	11
" " pref.	100	..	53
Buffalo St. Ry	100	66⅛	69
Cleveland City Ry.	100	68	70
Cleveland Electric Ry.	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	46	49
Consolidated Traction of N. J	..	30	33
Electric Traction, Philadelphia	50	78½	79
Long Island Traction	100	7	7⅛
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	88
Metropolitan Traction, Philadelphia	100	90	90⅛
New Orleans Traction	100	15	18
" pref.	100	56	60
North Shore Traction	100	..	..
" " pref	100	74	83
People's Traction $30 pd	25	54½	55⅛
Philadelphia Traction	50	89	89¼
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	61	61½
" " pref	100	87⅛	88
Worcester Traction	100	..	13
" " pref	100	77	80
BONDS.			
Buffalo St. Ry. 1st con. 5s	100	101	..
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	9	..
Rochester St. Ry. 1st. 5s	100	95	97
*Union Ry. 1st. mtge 6s	100	105	109
*Westchester Electric 1st. mtge. 5s	100	98	101

* With accrued interest.

† Ex-div.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, April 1, 1895.

MR. J. M. CUMMINGS, inventor of the well-known conduit, is in the city on business, and wears the genial smile characteristic of a manufacturer whose product is in heavy demand. The order recently received by the Cummings & Engleman Company from the Niagara Falls Hydraulic Power Company will cover over 30,000 feet of conduit.

J. H. BUNNELL & CO., 76 Cortlandt street, have put in handsome walls and ceiling of pressed steel, the design of which is very ornamental. Other improvements have also been made, and the interior of the store presents a strikingly handsome appearance. The headquarters of this progressive concern give no indication of anything like dull times.

MAXWELL M. MAYER, manufacturer of the iron-clad dynamo illustrated in our columns last week, removed his office some time since from 136 Liberty street to 411 107th street, New York, where his factory is located. In our article referred to, the old address was inadvertently given. Mr. Mayer has excellent facilities for turning out high grade work at short notice.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, March 30, 1895.

THE SENATE COMMITTEE on Street Railways in the Massachusetts Legislature has reported adversely on the petition to allow street railways to make contracts to carry United States mails or to carry freight, merchandise or express packages.

RAPID TRANSIT for Boston was practically inaugurated Thursday, the first spadeful of dirt being dug at the Public Garden end of the enterprise by Chairman Crocker of the Rapid Transit Commission. His Excellency Gov. Greenhalge assisted in the opening ceremony.

THE ELECTRIC HEAT ALARM COMPANY, of Boston, has always adopted most telling and effective methods to keep itself prominently before the public. The fertile brain and apparently inexhaustible energy of Mr. F. S. Palmer, its popular general manager, are always producing something in the line of credit to himself and profit to his company. His latest effort is in the form of a new catalogue of its heat alarm, fire alarm and thermostat systems, which is really a gem of beauty and neatness, the outside cover being in the form of a calendar which will guarantee unquestionably its preservation in the office or home.

BIBBER, WHITE & CO., the newly organized electrical firm, with offices at 620 Atlantic avenue, Boston, require introduction only because of their recent organization, all of the members composing it being well and favorably known. The executive head of the firm, Mr. C. E. Bibber, has already earned for himself an enviable reputation which he will undoubtedly fully sustain. The firm will have the sole selling agency of the wire and cable products of the Crofield Electrical Works, of Providence, R. I., and will also represent in New England the Cutter Electrical Manufacturing Company, of Philadelphia, whose specialties need no words of commendation.

General News.

TELEGRAPH AND TELEPHONE.

KINGSTON, N. Y.—The West Shore Telephone Company is rushing in telephones, and will be ready for business in a few days.

CARBONDALE, PA.—A telephone exchange company is to be organized. A. P. Trautwein, secretary of the Board of Trade, can furnish detailed information.

HARRIMAN, TENN.—M. L. Dame will give information regarding a complete equipment of 50 telephones to be purchased by the Harriman Co-operative Telephone Exchange.

ELECTRIC LIGHT AND POWER.

BENTON HARBOR, MICH.—Peter English has asked for a franchise to establish an electric light plant.

STATESBORO, GA.—W. D. Davis is contemplating the construction of an electric lighting plant in this town.

HARTFORD, CONN.—The extension of the electric light system is contemplated. Address the clerk of the council.

WINONA, MINN.—The city clerk will give information concerning the establishment of a municipal electric light plant.

GREENSBORO, N. C.—Bids will be received by A. M. Scales, city clerk, until April 28, for the electric lighting for this city.

DELAND, FLA.—An electric lighting system is to be established here in the near future. Address the clerk of the Council.

OGDENSBURG, N. Y.—The electric lighting of this city is contemplated. The town clerk can furnish detailed information.

NORWICH, CONN.—The erection of a municipal electric lighting plant is contemplated. Mayor C. A. Harwood can be addressed.

CHESTER, PA.—It is reported that the city is to be lighted throughout with electricity. The clerk of the Council can furnish details.

VERSAILLES, KY.—An electric lighting plant is to be built in this city in the near future. Address the mayor for detailed information.

McCOMB CITY, MISS.—The installation of an electric lighting plant is contemplated by Messrs. J. J. White, William Link and O. D. Quin.

ROCHESTER, N. Y.—Bids will be received for the lighting of the police station on Exchange street. Address the city clerk for details.

NEWBURYPORT, MASS.—The question of lighting the streets with electricity has been agitated. Address the clerk of the Council for details.

NORFOLK, VA.—An electric plant is to be built for the Portsmouth & Port Norfolk Railway. The most modern machinery will be introduced.

BLACKSTONE, R. I.—The residents of this town are agitating the question of an electric lighting system. The town clerk can furnish details.

BARDSTOWN, KY.—Address Arvil Arnold regarding estimates on an electric light plant, and estimates on lighting the city, with a 20 years' lease.

GOLIAD, TEX.— The Goliad Water & Light Company has applied for a franchise. W. E. Campbell, president of the company, can furnish information.

JAMESTOWN, N. Y.—The Council has been required to extend the electrical lighting system on several streets. The clerk of the Council can be addressed.

EVANSTON, ILL.—An electric light plant will be established, and an election held April 16 to vote on the question of issuing $38,000 of bonds for erecting same.

CLINTON, N. J.—Work will be commenced in the near future on the construction of the electric lighting plant. The clerk of the Council can furnish particulars.

BLOOMINGTON, ILL.—The Bloomington Electric Light & Power Company's plant, which was recently destroyed by fire, will probably be rebuilt in the near future.

KENSINGTON, MD.—The Common Council of this place is contemplating the lighting of the streets with electricity. Address the clerk for details.

TAMPA, FLA.—The purchase of an electric lighting plant for street lighting is contemplated by the city authorities. The clerk of the Council can be addressed.

THE FALL RIVER, (MASS.) ELECTRIC LIGHT COMPANY has petitioned for permission to establish its wires underground. The secretary can be addressed.

GOFFSTOWN, N. H.—An ordinance has been introduced authorizing the issuance of bonds for an electric light plant. For details address the clerk of the Council.

TAMAQUA, PA.—The residents of this place are contemplating the erection of an electric light plant. The clerk of the Council can be addressed for further information.

FAYETTEVILLE, N. C.—Authority was granted by the last legislature to establish an electric light plant. Bonds to the value of $10,000 will be issued for that purpose.

PARISH, N. Y.—Bids are to be advertised for the lighting of the streets of this village for a term of one year. W. B. Baxter, clerk of the Village Board, can be addressed.

GREEN ISLAND, N. Y.—A bill has been introduced authorizing the issuance of $20,000 worth of bonds for the purpose of establishing an electric light plant in this village.

WINCHESTER, MASS.—The establishment of a municipal electric lighting plant is contemplated by the town authorities. Address the town clerk for detailed information.

LIVINGSTON, ALA.—An electric lighting plant is to be established here. Bids for the construction of same will be received by W. R. Smith, secretary of the Commercial Club.

KAUFMAN, TEX.—The Kaufman Manufacturing Company is being organized for the purpose of building a woodenware factory. An electric lighting plant will be installed. H. J. Snow, of this place, is among those interested, and can be addressed.

TRENTON, N. J.—A bill has been introduced authorizing the construction and maintenance of a municipal electric lighting plant in this city. The city clerk can be addressed.

SHEBOYGAN, WIS.—Sealed proposals will be received until April 23 for lighting the streets of the city with electricity. John Schmitt, city comptroller, can furnish detailed information.

LOCKHART, TEX.—The Lockhart Electric Light Company is in the market for a 750-light incandescent dynamo. The secretary of the company can be addressed for detailed information.

NEW YORK CITY.—A seven-story apartment house will be erected at 28 West 23d street, and the building will be equipped for electric lights. Address W. J. Merritt, 339 Boulevard, for information.

NEW YORK CITY.—The new five-story public school building, which is to be erected on Henry street, will be lighted by electricity. Address C. B. J. Snyder, 146 Grand street, for detailed information.

NEW YORK CITY.—A seven-story building is to be erected at 352 Fourth avenue and another at 185 West 97th street. Both will be lighted electrically. Louis Kern, 611 Broadway, is the architect.

PORT HURON, MICH.—The establishment of an electric light plant is contemplated, and a meeting is appointed for April 1 in reference to issuing for its construction bonds to the amount of $30,000.

KINGSTON, N. C.—It is reported that an election is to be held in the near future to vote on the question of lighting this town with electricity. The town clerk can be addressed for detailed information.

HUMBOLDT, TENN.—An election is to be held to vote on the question of issuing $15,000 worth of bonds for the construction of a water works and electric lighting system. The mayor can be addressed.

PITTSBURGH, PA.—Sealed proposals will be received until April 18 for the electrical work for the Fifth avenue high school building. Charles Reisfer, secretary of the Board of Education, can be addressed.

LOCKPORT, N. Y.—It is reported that at the charter election, to be held April 9, the citizens will vote on the question of establishing a municipal lighting plant. Address the clerk of the Council for details.

ATLANTA, GA.—Plans have been prepared by H. M. Atkinson for the lighting of the Exposition grounds with electricity. The plant will have a capacity of 500 arc lights, of 2,000-cp each, and 2,000 incandescent lights.

SEA CLIFF, L. I., N. Y.—The Franklin Electric Illuminating Company has been granted permission to erect poles and string wires in this village. The secretary of the company can be addressed for detailed information.

PHILADELPHIA, PA.—The Junger Maennerchor Hall is to be extensively enlarged and improved at an estimated cost of $30,000. An electric plant is to be installed. Louis Hummel is secretary, and can be addressed for details.

ROCHESTER, N. Y.—Address Edward Harris, 15 Rochester Savings Bank Building, concerning the erection of an electric plant capable of lighting the village of Charlotte, for the Grand View Beach Electric Railway Company.

GREEN ISLAND, N. Y.—A bill has been introduced authorizing this village to issue $20,000 worth of bonds for the erection, equipment and maintenance of an electric lighting plant. Address the town clerk for detailed information.

NEW YORK CITY.—The eight-story store building to be erected in this city for Messrs. Siegel, Cooper & Co., of Chicago, is to be wired and fixtured throughout for electric lighting. An isolated plant will probably be installed.

LAUREL, MD.—The plant of the Laurel Electric Light, Power & Heat Company was recently sold to Jos. Friedenwald and a Mr. Miller, of Baltimore, for $7,000. The plant cost $14,000, and the purchasers were creditors in the sum of $5,000.

RIDGEWOOD, N. J.—Architect Charles E. Keyser, 209 Main street, Paterson, has prepared plans for a stone residence for Mr. Wortendyke of Paterson, at a cost of $15,000. The structure will be wired and fixtured throughout for electric lighting.

MARIETTA, PA.—The Marietta Electric Light, Heat & Power Company has been awarded the contract to light the streets of this city. It has also been granted permission to use the streets for its lines. A. D. Wike, of this place, is secretary.

NEW YORK CITY.—The 20-story office building which is to be erected for Henry O. Havemeyer, 117 Wall street, after plans prepared by G. G. Post, 33 East 17th street, is to be lighted throughout by electricity. An isolated plant will be installed.

CHATHAM, N. Y.—Sealed proposals will be received until April 8 by the Board of Trustees for lighting the streets of the village for a period of five years. Eighty-five incandescent lights will be required. W. B. Daley, village clerk, can furnish other details.

ASBURY PARK, N. J.—The Neptune Electric Company's plant was recently sold at auction to Mr. Geo. A. Smock, representing the Asbury Park Electric Light Company, the price paid being $60,000. The plant has been in receiver's hands several weeks and is mortgaged to the amount of $41,000.

WILLOUGHBY, O.—C. C. Jenkins, clerk, may be addressed regarding the furnishing of apparatus, appliances, material, and erecting and completing an electric light and power plant according to plans and specifications on file in the office of J. S. Ellen, mayor. Bids will be received until April 17.

BROOKLYN, N. Y.—Plans have been prepared by Architect C. P. H. Gilbert, 18 Broadway, New York, for a two and one-half story brick addition to the Dutch Arms clubhouse. The structure will be provided with all modern improvements, and will be wired and fixtured throughout for electric lighting. Estimated cost $15,000.

OCEAN VIEW, VA.—Plans have been completed for an electric light and power plant to be built for the Norfolk & Ocean View Railway Company, Norfolk, Va., at a cost of $80,000. Two 250 hp engines and all necessary electrical appurtenances will be required. H. L. Page is secretary of the company, and can furnish particulars.

CHARLOTTESVILLE, VA.—The Jefferson Park Company, which was recently incorporated, has decided to begin work soon on the erection of its electric lighting plant. All the necessary machinery will be required for a plant of 2,000 incandescent lights capacity. F. B. Peyton, secretary of the company, can furnish further information.

THE ELECTRIC RAILWAY.

CHARLESTON, S. C.—A company is being organized to build an electric road from Charleston to Summerville.

MEDFORD, N. J.—The question of building a trolley line through this town is being agitated. The town clerk can be addressed.

NEW YORK CITY.—A bill has been introduced authorizing the construction of a street railway on Fifth avenue south of 24th street.

NEWBURGH, N. Y.—The construction of a trolley line is contemplated from this place to Walden. Address the clerk of the Council.

MEMPHIS, TENN.—A franchise has been applied for by Messrs. Gowdon, Proudfit and J. W. Allison to build a trolley line in this city.

BALTIMORE, MD.—The Baltimore Traction Company will extend its Edmondson avenue line to Orangeville in the eastern suburbs.

PITTSTON, PA.—The Pittston Suburban Electric Railway Company has applied for an extension of time of one year to complete its line.

COHOES, N. Y.—President Weldon has announced his intention of constructing an electric railway to connect Cohoes with Dunsbach's Ferry.

BRADDOCK, PA.—Preparations are being made to double track the Braddock & Turtle Creek line. Address the secretary of same for particulars.

BEVERLY, MASS.—A new power station is to be erected here for the Gloucester, Essex & Beverley Street Railway. The secretary can be addressed.

COHOES, N. Y.—The Cohoes City Railway Company will establish a power house on the Erie Canal. The secretary of the company can be addressed.

POTTSVILLE, PA.—A new trolley road is to be built from this place to Minersville, a distance of 10 miles. The clerk of the Council can be addressed.

DOVER, DEL.—It is reported that a new electric railway is to be built between this city and Milford. Address the clerk of the Council for detailed information.

DANVILLE, VA.—It is reported that the street railway line is to be extended to Reservoir Park. The general manager can be addressed for further information.

BLOOMINGBURG, N. Y.—The traction company of Middletown is contemplating the extension of its line to this village. The secretary can furnish details.

CARTHAGE, MO.—An electric railway 11 miles in length is to be built between this place and Webb City. President Calhoun can furnish further information.

BATH ON THE HUDSON, N. Y.—A franchise has been applied for by a new company to construct an electric railway. Village Clerk Wornham can give information.

PEEKSKILL, N. Y.—An electric road is projected from this place to Brewster via Carmel and adjacent villages. George M. Bailey is interested, and can be addressed.

LA SALLE, N. Y.—Work is to be commenced in the near future on the construction of the Buffalo & Niagara Falls Electric Railway to be built between the points named.

KANSAS CITY, MO.—An electric power plant is to be established here for the Independence dummy line at a cost of $20,000. The secretary of the road can furnish details.

ATLANTIC CITY, N. J.—New York and Atlantic City capitalists have formed a syndicate to build an electric railway from New York to Atlantic City. Capital stock is $4,000,000.

ALBANY, N. Y.—Right of way is being secured for the electric railway which is to extend between this city and Schoharie. The clerk of the Council can furnish information.

PHILADELPHIA, PA.—Penrose Ferry Trolley Company has been granted permission to build a passenger railway in this city. The secretary of the company can be addressed.

HARTFORD, CONN.—It is reported that the Montville Horse Railway Company is to equip its line with electricity. Address the secretary of the company for further information.

EAST GREENBUSH, N. Y.—A franchise has been applied for by the electric railway company to construct their line through this town. The clerk of the Council can be addressed.

ORANGE, N. J.—The Consolidated Traction Company has been granted the privilege of a switch at Main street and Lincoln avenue. The secretary of the company can be addressed.

DOYLESTOWN, PA.—A trolley line is to be built from this place to Philadelphia as soon as possible. The secretary of the Bucks County Street Railway Company can be addressed.

ERIE, PA.—An ordinance has been introduced authorizing the Erie Transit Company to lay tracks on certain streets of the city. The secretary of the company can furnish particulars.

MOHAWK, N. Y.—The Mohawk, Herkimer & Ilion Street Surface Railway has decided to equip the line with electricity in place of horses. The secretary of the company can be addressed.

SCRANTON, PA.—The Scranton Traction Company has applied for permission to double track its lines on Franklin avenue. President Nealis, of the Common Council, can be addressed.

PHILADELPHIA, PA.—The question of establishing a system of elevated roads in this city is being agitated. A bill has been introduced in the Senate authorizing the construction of same.

SHARPSBURG, PA.—The Millvale, Ætna & Sharpsburg Traction Company will begin work on its projected line as soon as the weather permits. Address the secretary for detailed information.

SOUTH ORANGE, N. J.—The South Orange & Maplewood Traction Company has applied for a franchise to construct a line over Springfield avenue. The secretary of the road can be addressed.

PORTSMOUTH, VA.—The management of the Portsmouth Street Railway will build a new electric power plant, to be provided with the latest machinery. Address the secretary of the road for details.

HARTFORD, CONN.—The Hartford Street Railway Company has asked for permission to run its line from Wethersfield Avenue station to the city hall. General Manager Crawford can be addressed.

PARKERSBURG, W. VA.—It is reported that the Park City Railway is to be purchased by W. R. Hura and others, who contemplate equipping same with electricity. President Gould can be addressed.

SYRACUSE, N. Y.—The Syracuse & East Side Railway Company has been granted permission to construct, maintain and operate a single track electric street railway through certain streets of the city.

TOLEDO, O.—We are informed that an electric railway is to be built from this city out into Williams County, for a distance of 45 miles. The clerk of the Council can be addressed for further information.

CLARKSVILLE, N. Y.—The question of building an electric railway from this place to Schoharie is being agitated. J. McNamara, of Albany, is interested, and can be addressed for detailed information.

PATERSON, N. J.—We are informed that the Paterson Electric Railway Company has decided to double track its line from this city to Passaic. The secretary of the company can be addressed for details.

BUFFALO, N. Y.—It is reported that the New York Central Railway Company is to equip its Niagara Falls branch of the line with the electric trolley system. The secretary can furnish further particulars.

MONTCLAIR, N. J.—It is reported that the Montclair Town Council will grant the franchise which was applied for by the North Jersey Traction Company. The secretary can be addressed for detailed information.

WASHINGTON, PA —It is reported that the street railway is to be extended from its present terminus near the W. & W. station to the foot of Atcheson avenue. Address the clerk of the Council for particulars.

PHILADELPHIA, PA.—Work will be commenced shortly on the construction of the Delaware Valley Electric Railway. Capt. Rockwell, of the Rockwell Construction Company, Middletown, N. Y., can be addressed.

FALL RIVER, MASS.—The Globe Street Railway Company has petitioned for the franchise to maintain an underground system of electrical feed wires. F. S. Stevens, president of the company, can be addressed for details.

GREENBUSH, N. Y.—A meeting is to be held April 15 by the Board of Trustees to consider the advisability of granting a franchise to the Albany & Greenbush Electric Railway. Frederick R. Barnes can furnish particulars.

PATCHOGUE, L. I., N. Y.—It is reported that a trolley road 15 miles in length is to be built across Long Island from Port Jefferson to this place. O. T. Fanning, of the former place, is interested, and can be addressed.

MARSHALL, MO.—A syndicate of which W. G. Campbell, of Oakland, Cal., and W. M. Walker, of this place, are members, is contemplating the construction of an electric railway, 40 miles in length, between this city and Sedalia.

DEXTER, N. Y.—The Dexter & Brownsville Street Railway Company has applied for permission to construct, maintain and operate an electric railway between the points named. Wm. H. Winn, village clerk, can give information.

SYRACUSE, N. Y.—The Syracuse Street Railway Company contemplates the erection of a new structure to accommodate all the electric cars used on the lines. It will be two stories high and accommodate 60 cars on the ground floor.

READING, PA.—Work will be commenced immediately on the construction of the Reading & Womelsdorf Electric Railway, which is to be built between the points named, a distance of 14 miles. The secretary of the road can furnish details.

WETHEREDVILLE, MD.—The county commissioners of Baltimore County have granted a franchise to William J. Dickey, Charles W. Dorsey and others to construct an electric railway over the Wetheredville road from Windsor Bridge to this place.

ROCHESTER, N. Y.—An application has been made to the Common Council by the Rochester Railway Company for a franchise to construct a double track street railway through certain streets of this city. Address the secretary of the company for details.

ROCHESTER, N. Y.—The Rochester, Charlotte & Manitou Railway Company has purchased the old Grand View Beach Railway, which will be improved and operated. Michael Doyle and Valentine Fleckenstein are among the directors, and can be addressed.

STOUGHTON, MASS.—The Stoughton & Canton Street Railway Company has been organized for the purpose of building a line between the points named. The line will be about three miles in length. E. C. Monk is on the board of directors, and can be addressed.

WESTCHESTER, N. Y.—The Edenwald Street Railway Company, of East Chester, has applied for a franchise to construct a line from Wakefield to East Chester, and to this place, via the old Boston coast road. Address the secretary of the company for information.

MT. VERNON, N. Y.—The directors of the North Mount Vernon Railway Company propose to continue the line from here to New Rochelle and White Plains, and from New Rochelle to Tuckahoe. It will be several months before the active work of construction is commenced.

WILKESBARRE, PA.—The Wilkesbarre & Wyoming Valley Traction Company will issue $350,000 worth of bonds for the purpose of building a new line on the east end, double tracking the Nanticoke line, and building a new power and car house. Address the secretary of the company for detailed information.

TURNER'S FALLS, MASS.—A company has been organized with a capital stock of $40,000, for the purpose of building an electric railway from this place to Lake Pleasant and Miller Falls, a distance of five miles. A franchise is to be applied for, and work will be commenced as soon as possible. Address the clerk of the Council for particulars.

BLAISDELL, N. Y.—A company has been organized with a capital stock of $10,000, to be known as the Hamburg Railway Company. The purpose of the company is to construct, operate and maintain a street railway from this place to Woodlawn Beach. James E. Curtis, Frank B. Caldwell and others are among the incorporators, and can be addressed.

Trade and Industrial Notes.

THE METROPOLITAN ELECTRIC COMPANY, Chicago, reports that it is finding a very ready sale for its new carbon open circuit battery, recently put on the market.

ARCHER & PANCOAST, manufacturers of electrical fixtures, have removed their headquarters from the corner of 20th street and Broadway to 18 and 20 West 25th street.

THE ELECTRIC POWER STORAGE COMPANY, manufacturers of accumulators, has removed its offices from the Havemeyer Building to its factory building, 166 Elm street.

W. D. JAMESON, general sales agent of the Gerson Telephone Company, has moved his office from 150 to 44 and 46 Broadway, New York City. Mr. Jameson reports business very good and the demand increasing for his telephone.

THE GOUBERT MANUFACTURING COMPANY, New York, makers of the Goubert Feed Water Heater and Stratton Steam Separator, has lately removed its Pittsburgh office from 403 Lewis Building to 1012 Carnegie Building.

J. C. HOBART, the well-known manager of the Triumph Electric Company, Cincinnati, O., recently made a very successful business trip to Xenia, O., where he received the contract for installing the electric plant of the Willberforce University.

THE MERRILL MANUFACTURING COMPANY, 126 Liberty Street, New York, has issued a neat illustrated catalogue descriptive of its pneumatic pumps and air compressors. Mr. F. H. Merrill's ingenious method of elevating water by means of compressed air is fully described in the book.

THE WASHINGTON CARBON COMPANY, of Pittsburgh, Pa., manufacturer of Helios cored carbons, reports that these well-known goods are continuing to give absolute satisfaction, and that companies using them say that they are even better than the foreign product which stands so high.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports the sale through Messrs. H. B. Coho, & Co., its New York contractors, of one 30-kw and two 50-kw direct-connected generators of the new type for Grace Chapel, 17th street, New York City. Armington & Sims engines will be used.

THE RICE & SARGENT ENGINE COMPANY, of Providence, R. I., reports sales up to March 16 of a 300-hp tandem compound to Pembroke Mills, Suncook, N. H.; a 200-hp engine to the Lawrence Lumber Company, Lawrence, Mass., and a 75-hp engine to the Oakdale Manufacturing Company, of Providence, R. I.

THE INDIANAPOLIS ELECTRIC COMPANY, of Indianapolis,, Ind., reports a steady growth in its telephone business. Over 100 telephones of another make have been displaced up to date by this company's instruments. The company's work has thus far been chiefly in the direction of equipping railway telephone lines.

MR. T. J. MURPHY, of T. J. Murphy & Co., 136 Liberty street, New York, has applied for patents on some of his new devices, notably his method of mounting switchboards, which dispenses with all iron uprights, cross pieces and frame work. His patent applications also include some of his numerous designs for slate-lined boxes.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has just issued a circular of its improved Hunnings telephone and American telephone switchboard, which sets off these articles to advantage. Its switchboard is a very neat and artistic device, and certain advantages in its battery telephone are claimed over any other on the market.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has secured the contract for the new power house of the Metropolitan Electric Company, Reading, Pa. The company is building a warehouse, 120 feet square and 12 stories high, for James Everard, New York City. This building has a steel frame, and will be entirely fireproof.

DALE, FARRELL & CO. is the style of a new firm of electrical and mechanical engineers and contractors, with headquarters at 70 Trinity place, New York. The firm will do manufacturing, and has a factory for that purpose at 214-218 William street. Mr. F. J. H. Dale, the senior member, is an engineer and draughtsman of many years' standing, and Mr. P. H. Farrell is a practical tool maker.

THE HARRISON SAFETY BOILER WORKS, of Philadelphia, has issued an illustrated pamphlet catalogue descriptive of the Cochrane separators, of which the Harrison Company is the manufacturer. The information presented is very complete, detail drawings and explanations being given of each form of separator. Many strong testimonials as to the excellent service experienced with these separators are reprinted in the catalogue.

THE STANDARD TOOL COMPANY, of 146-150 Centre street, New York, is distributing a unique advertising card, upon the face of which is an imitation oyster shell bearing the inscription: "Perhaps there is a pearl in this oyster." Raising the shell, which is secured at the upper end only, discloses a miniature twist drill under which is the statement "Not a pearl, but a gem in its way." The device is a very taking one.

THE LUKENS IRON & STEEL COMPANY, of Coatesville, Penn., reports the receipt of an order for 6,000 tons of open hearth steel plates to be used in the construction of the cantilever bridge across the East River at Blackwell's Island, New York City. The Lukens Company has also received large orders for boiler steel from Cramp & Sons, the Philadelphia shipbuilders, for the new Clyde line steamship, and from the Pennsylvania Railway Company, the Lehigh Valley Railway Company, the Schenectady Locomotive Works, and others for boiler and firebox steel.

THE WALKER MANUFACTURING COMPANY, Cleveland, O., reports the following contracts closed between March 1 and 22: Burhorn & Granger, 136 Liberty Street, New York City, two 25-kw direct-coupled lighting generators; F. E. Snow, receiver Adrian City Electric Belt Railway Company, Adrian, Mich., one 60-kw belted generator and three 25-hp single equipments; Union Depot Railway Company, St. Louis, Mo., 41 double car equipments, 30 hp steel motors; Pittsburgh Traction Company, Pittsburgh, Pa., one double car equipment, 30-hp steel motors; Pittsburgh, Crafton & Mansfield Passenger Railway Company, Pittsburgh, Pa., one double car equipment, 50-hp steel motors; Federal Street & Pleasant Valley Passenger Railway Company, Pittsburgh, Pa., two double car equipments, 30-hp steel motors; Suburban & Rapid Transit Street Railway Company, Pittsburgh, Pa., one double car equipment, 25-hp steel motors; Schuylkill Electric Railway Company, Pottsville, Pa., four double car equipments, 25-hp steel motors; Chicago City Railway Company, Chicago, Ill., 49 double car equipments, 25-hp steel motors.

Business Notices.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention, Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

WESTERN ELECTRIC COMPANY, of Chicago, is carrying a complete line of Perfection Dynamo Brushes, and can supply the western trade at short notice. This brush is made of woven wire mesh cut on the bias, and has no stitching or solder on the working end. It is flexible, and made of copper of the highest conductivity. The above sale was made through the Chicago office of Chas. E. Chapin, by Ernest Wm. Cooke, manager, 1649 Monadnock Building.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 26, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

RE-ISSUE 11,481. CLOSED CONDUIT ELECTRIC RAILWAY; W. Lawrence, New York, N. Y. App. filed March 13, 1894. The combination of an insulated conductor main, branch conductors leading therefrom, contacts connected therewith, vertically movable rods, independently movable contact points to co-operate with the ones first mentioned, the said rods united at their upper ends with the service conductors, and at their lower portion with levers connected with one set of said contacts, one rod being located near each end of each section, casings enclosing said contacts and located exterior to the conductor main and communicating therewith only by the branch conductors, and means whereby the rods are elevated simultaneously with the movement of the said contact points.

536,184. METHOD OF APPLYING INSULATION; F. E. Case, Schenectady, N. Y. App. filed June 21, 1894. The method of applying insulation to metal parts, which consists in interposing between the parts a compressed material adapted to expand under heat and retain its expanded form when cold, and then heating the parts.

536,210. ELECTRICAL SIGNALING APPARATUS; W. H. M. Jackson, San Francisco, Cal. App. filed June 8, 1893. The combination with an electrical signal sending device, of a main circuit connecting with a receiving device, said circuit when closed, being continuous through a local source of electrical energy; the coils of an electromagnet, the body of an armature, and a back contact, but normally broken between said armature and back contact.

536,221. ELECTRIC SWITCH; C. J. Miller, Philadephia, Pa. App. filed Jan. 19, 1895. The combination of the terminals, the pivoted knife having yielding side plates, a tapered spring adapted to pass between the side plate and to force them out against the contacts, and a pivoted handle acting to withdraw the spring from between the side plates of the knife, and place it under tension, whereby the movement of the knife is accelerated as it is withdrawn from the contacts.

536,226. MAGNETIC SEPARATOR; J. D. McKinnon, Portland, Ore. App. filed Aug. 7, 1894. A magnetic separator comprising a suitable frame, two magnetic cylinders supported therein, an endless metallic belt connecting the cylinders, a pulley, a non-metallic belt passing over the metallic belt, and also over the pulley, an agitator arranged in the magnetic field, a suitable means of feeding the material to be separated, and two chutes disposed in opposite directions and meeting at a point where the belt becomes demagnetized so as to receive the separated material. (See illustration.)

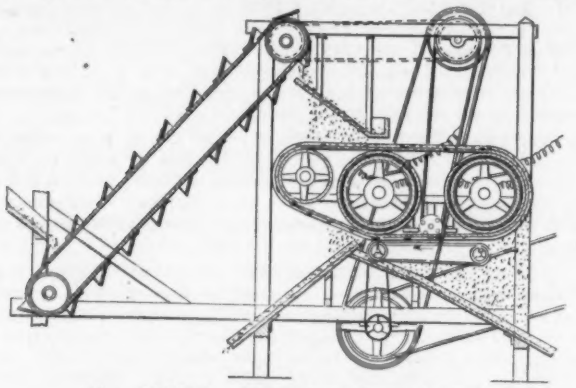
536,233. TELEPHONE SYSTEM; J. I. Sabin and W. Hampton, San Francisco, Cal. App. filed Nov. 9, 1894. The combination with a telephone line extending to a board at the central station, and terminating in a switch thereon, of a local trunk line plug at said board, a switch at an auxiliary or assistant operator's board connected with said local trunk line plug, a telephone line extending to a board at a distant exchange, and a main trunk line extending between a plug at said auxiliary board and a switch at the head of the distant exchange.

536,250. ADJUSTABLE SWITCH FOR TROLLEY SYSTEMS; M. M. Wood, Chicago, Ill. App. filed July 14, 1894. The combination in a switch for trolley systems of one or more tongues adjustably attached to a plate or

body portion and a mechanical clamping device associated with each of said tongues and adapted to be manipulated so as to clamp or unclamp the trolley wire at will.

536,266. ELECTRIC SWITCH; C. C. Chesney, Pittsfield, Mass. App. filed Jan. 17, 1895. The combination of a jaw and a lever bar bearing a contact blade, both mounted upon an insulating base with a casing enclosing said jaw, and having a slide normally covering said jaw, said lever bar having a projection controlling the position of the slide when the bar is depressed.

536,271. ELECTRICAL SIGNAL AND SWITCH OPERATING APPARATUS; J. Dutrey, New Orleans, La. App. filed July 19, 1894. The combination



No. 536,226.—Magnetic Separator.

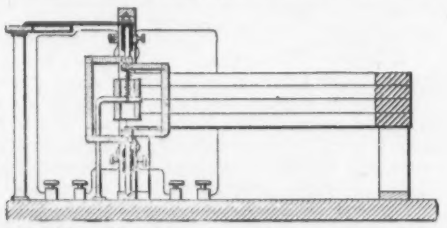
with a locomotive or car, and contact devices comprising spring pressed plungers, arranged on the locomotive or car, a lever provided with a detent adapted to engage the notches of the rack, and cords or chains connecting the lever and the plungers of the contact devices.

536,275 SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; C. E. Emery, Brooklyn, N. Y. App. filed March 15 1894. The combination with railway tracks and with a car thereon carrying electric apparatus, of a non-insulated conduit, a series of live supports connected to an electric generator through a main electric conductor and a series of intermediate supports, both arranged within the conduit and adapted to support a flexible conductor, and a drag arm passing through a slot in such subway and carrying an electric conductor insulated from such slot and connected to electric apparatus on the car, and to a flexible conductor operating in connection with such supports.

536,311. FUSIBLE CUT-OUT; J. J. Wood, Fort Wayne, Ind. App. filed Dec. 27, 1894. A fuse box having circuit terminals, a lid therefor having overhanging ribs, and an insulating fuse block detachably held by said ribs, carrying the fuse and having fuse terminals adapted to connect with said circuit terminals when the lid is closed, whereby it is detachably connected to the lid so that it may be removed bodily carrying the fuse with it.

536,319. METHOD OF INSULATING HIGH TENSION COILS OF TRANSFORMERS; A. Schneller and W. J. Wisse, Haarlem, Holland. App. filed Dec. 27, 1894. A secondary coil for a transformer composed of wire covered with several layers of insulating material and the convolutions of which are embedded in wax or a waxy substance, and are separated from one another in a circular direction by strips or layers of insulating material, and are firmly secured together by binding cords passed several times transversely through the coil, which is finally provided with an outer protecting layer of material.

536,374. CONDUIT ELECTRIC RAILWAY; F. S. Davenport, Jerseyville, Ill. App. filed Jan. 28, 1895. The combination of an insulated feed wire, a casing secured to the wall of the conduit and adapted to enclose and support said feed wire openings in the insulated covering of the feed wire, and bands of insulating material adapted to hermetically close said openings, metallic contact studs passing through and made air-tight in said elastic covers, and rigidly secured in metallic spring arms insulated from the feed wire, a collecting contact bar supported by but insulated from arms depending from the car truck, said collecting bar adapted to come in contact with and depress the free ends of the spring arms so as to press the contact studs upon the feed wire as it travels over them, and an insulated wire for electrically connecting the collecting bar with the motor.



No. 536,478.—Combination Electrical Meter.

536,382. TELEPHONE EXCHANGE SYSTEM; S. W. Holman, Boston, Mass. App. filed March 24, 1894. The combination of a metallic thimble placed upon a finger of one hand whereby the operator at the telephone exchange may, by simultaneously touching one metallically tipped finger to the open terminal of a grounded generator and the other metallically tipped finger to the appropriate subscriber's terminal upon the switchboard, send a calling signal to any desired subscriber.

536,417. FLEXIBLE TUBE; H. H. Brooks, Medford, Mass. App. filed Sept. 18, 1894. A flexible metallic tube having an internal spiral reinforce, composed of a strip of paper material, the inner tube serving to preven indentation.

536,420. TELEPHONY; P. B. Delany, South Orange, N. J. App. filed Nov. 19, 1894. An automatic transmitter comprising a tape having two lines of perforations therein, contact devices operating through each line of perforations, a split battery, a local circuit controlled thereby, a polarized relay in said local circuit whose armature is normally maintained in a neutral position, and is capable of movement therefrom in either direction, according to the polarity of the current in its coils, transmitting devices controlled by the armature of the polarized instrument in combination with a line circuit, and a battery from which successive currents of electricity are sent into the line, the polarity of such currents being determined by the direction of movement of the normally neutrally maintained armature lever.

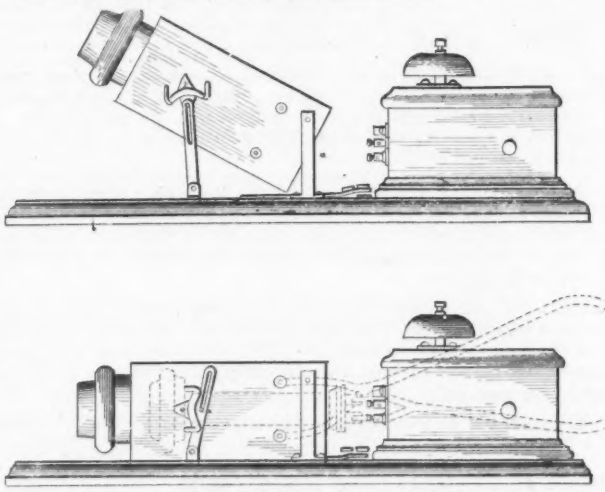
536,429. SIGNAL FOR RAILWAY CROSSINGS; E. A. Herman, St. Louis, Mo. App. filed Oct 1, 1894. The combination with a trolley wire of a pivoted arm which supports the same, a contact point in the path of said arm, whereby upon the passage of a trolley wheel the arm is raised into electrical contact therewith, a wire which leads from said contact to lamps located in a signaling box, and a bell which is operated by a shunted circuit.

536,439. ARMATURE FOR ELECTRIC MACHINES; E. C. Morgan, Chicago, Ill. App. filed July 18, 1894. An armature for an electric machine having its coils connected by an independent conducting plate and an insulating wedge through which the plate passes and by which it is braced.

536,467 ELECTRIC SIGNAL SYSTEM; W. Gillette and A. S. Williams, New York, N. Y. App. filed Oct. 30, 1894. The combination with the telephone switch for controlling the line and local circuits, of a single plug having a single contact surface switch for throwing one pole of the connections of the battery and one pole of the secondary of the induction coil into electrical connection with the line.

536,478. COMBINATION ELECTRICAL METER; Herschel C Parker, Brooklyn, N. Y. App. filed Jan. 9, 1895. An electrical meter, comprising a magnet, a pair of rotatable mounted coils arranged in inductive proximity to the magnet, and having their terminals adapted for connection independently of each other, said coils being of different resistances, and an index actuated by the movement of the coils. (See illustration.)

536,481. TELEPHONE; J. D. Price, Chicago, Ill. App. filed July 30, 1894. The combination with a telephone of a transmitter box hinged or pivoted to its support, having a hook or receptacle for the receiving instrument pivoted to the side, and mechanically connected with the back-board or supporter in such a manner that when the transmitter box is in one position the hook will support the receiver, and in another position the hook is inverted and will not support the receiver. (See illustration.)



No. 536,481.—Telephone.

536,530. ELECTRIC CURRENT REGULATOR; C. M. Jordan, Washington, D. C. App. filed Feb. 13, 1895. A current regulator for working circuits comprising a branch or shunt circuit deriving its current from the working circuit, and having a current of a pre-determined fixed strength of intensity, a motor within and driven by said branch or shunt circuit, a current regulator or controller with the working circuit, and a differential mechanism driven by and between the said motors and the current regulators.

536,535. ELECTRIC BRAKE; E D. Lewis, Savona, N. Y. App filed Nov. 12, 1894. In an electric brake, a fixed electromagnet, a movable electromagnet in the same circuit having a rod projecting, a hanger supporting the rod, and brackets, a pivot rod adjustably secured to the brackets, a brake lever mounted on the pivot rod and connected at one end to the rod, and a spring also connected to the brake lever.

536,547. SYSTEM OF ELECTRICAL SIGNALING FOR RAILWAYS; C. Selden, Baltimore, Md. App. filed Dec. 26, 1894. In a system of electrical signaling for railways an electromagnetic instrument consisting of a base containing a pair of magnets at one end, and with an electromagnet at the other end, the pair being arranged at right angles to each other, and adapted to unlock and lock the armatures and so control the signal circuit and the circuit of the electromagnet at the other end. An escapement device controls the back movement of the last magnet, and suitable track contacts properly spaced give a car or train sufficient time to clear the space between the two last track contacts.

536,559. RELAY; C R. J. Willot, Paris, France. App. filed Nov. 24 1893 A relay for electric telegraphs comprising two movable armatures fixed on the same axis, and an electromagnetic system in a magnetic circuit closed by means of two breech pieces and a combined magnetic field with two magnets acting simultaneously upon the mass of the soft iron of the electromagnet and upon said armatures.